NASA CR- 139035

A STUDY OF REMOTE SENSING AS APPLIED TO REGIONAL AND SMALL WATERSHEDS

IBM No. 74W-00176

FINAL REPORT

VOLUME II - SUPPORTING TECHNICAL DETAILS

HUNTSVILLE

(NASA-CR-139035) A STUDY OF REMOTE SENSING AS APPLIED TO REGIONAL AND SMALL WATERSHEDS. VOLUME 2: SUPPORTING TECHNICAL DETAILS (International Business Machines Corp.) ~~442~~ 412 p HC CSCL 08H G3/13

N74-30833

Unclas 46046

IBM

412

TABLE OF CONTENTS

Section		Page
	Preface	iii
5	WATERSHED SIMULATION MODELS	5-1
5.1	Watershed Modeling and Streamflow Forecasting	5-1
5.2	The Stanford Watershed Model (SWM)	5-2
5.3	Kentucky Watershed Model (KWM) and OPSET Program	5-3
5.3.1	Kentucky Watershed Model	5-5
5.3.2	OPSET and Calibration	5-5
5.4	The NASA-IBM System for Simulation and Analysis of Watersheds	5-9
5.4.1	Watershed Model Data Base	5-9
5.4.1.1	Historical Data	5-9
5.4.1.1.1	Hourly Precipitation Data	5-11
5.4.1.1.2	Daily Discharge (Streamflow) Data	5-12
5.4.1.1.3	Flood Hydrographs	5-12
5.4.1.1.4	Evaporation Data	5-12
5.4.1.1.5	Temperature Data	5-13
5.4.1.1.6	Snowmelt Data Arrays	5-13
5.4.1.2	Parameters	5-14
5.4.1.3	Calibration	5-15
5.4.1.4	Integrated Data Base	5-17
5.4.2	Simulation Program Outputs	5-17
5.5	Watershed Simulation in This Study	5-19
6	SENSITIVITY ANALYSIS	6-1
6.1	Methodology	6-1
6.1.1	Performance Indices	6-1
6.1.2	Sensitivity Analysis Tabulations	6-2
6.1.3	Sensitivity Plots	6-2
6.2	Summary of Results	6-2
6.3	Detailed Sensitivity Analysis Results	6-9
6.3.1	FIMP, Impervious Fraction of Watershed Area	6-9
6.3.2	FWTR, Water Surface Fraction of Watershed Area	6-26

TABLE OF CONTENTS (Continued)

Section		Page
6.3.3	VINTMR, Vegetative Interception Maximum Rate	6-41
6.3.4	BUZC, Basic Upper Zone Capacity	6-57
6.3.5	SUZC, Seasonal Upper Zone Capacity Factor	6-67
6.3.6	LZC, Lower Zone Capacity	6-79
6.3.7	ETLF, Evapotranspiration Loss Factor	6-92
6.3.8	SIAC, Seasonal Infiltration Adjustment Factor	6-104
6.3.9	BMIR, Basic Maximum Infiltration Rate	6-113
6.3.10	Overland Flow Surface Slope	6-125
6.3.11	OFSL Overland Flow Surface Length	6-135
6.3.12	OFMN, Overland Flow Roughness Coefficient	6-146
6.3.13	RGPMB, Recording Gage Precipitation Multiplier	6-154
6.3.14	Evaporation and Mean Number of Rainy Days	6-161
6.3.15	Sensitivity of Small Snowshed Model to Climatological Input Perturbations During Storms	6-176
6.3.16	FIRR, Fraction of Incident Radiation Reflected by Snow	6-181
6.3.17	BODFSM, Basic Degree Day Factor for Snowmelt	6-184
6.3.18	SPBFLW, Snowpack Basic Maximum Fraction in Liquid Water	6-187
6.3.19	SPTWCC, Snowpack Minimum Total Water Content for Complete Basin Coverage	6-190
6.3.20	ELDIF, Elevation Difference Between the Base Thermometer and the Mean Basin Elevation	6-192
6.3.21	FFOR, Fraction of the Watershed Forested	6-195
6.3.22	Fraction of Snow Intercepted	6-198
6.3.23	PXCSA, Precipitation Index for Changing Snow Albedo	6-201
7	RELATED TECHNICAL ARTICLES AND ABSTRACTS	7-1

PREFACE

This volume represents detailed technical material supplementing and supporting Volume I, Summary Report. For the convenience of the reader, some of the material from Volume I has been duplicated here to minimize cross references. Distribution of this volume is very limited in comparison with that of Volume I.

Section 5 describes the application of continuous watershed simulation models in the study, and Section 6 presents detailed results of the sensitivity analysis, the study's principal task. Portions of watershed model simulation run outputs are presented in Appendices A, B, and C. Abstracts of related technical articles appear in Appendix D.

SECTION 5

WATERSHED SIMULATION MODELS

This section is intended to describe how continuous simulation models of watersheds were used in performance of the study. The models' underlying theory and inner workings are discussed only to the extent necessary to explain their application as study tools.

5.1 WATERSHED MODELING AND STREAMFLOW FORECASTING

That aspect of hydrology known as streamflow forecasting undertakes to predict the outflow from a river basin, in terms of flow rate as a function of time, in response to a given precipitation event under given initial conditions. This capability is vital to effective planning for urban/industrial development, flood control, hydroelectric power, navigation, and water resources management.

Figure 5-1 depicts the cross section of a somewhat idealized rural catchment and identifies the principal phenomena at work in the rainfall-runoff relationship. The input (precipitation) is partially intercepted by vegetation and water retention areas. Moisture reaching pervious surfaces divides between overland flow, infiltration, and evaporation. Through subsurface processes, interflow, and groundwater flow contribute ultimately to streamflow, with some losses due to transpiration through plant life. In certain regions, in winter, moisture is stored in the form of snow in portions of the basin, and melts to produce additional moisture movement in spring.

All the phenomena involved in this portion of the hydrologic cycle are widely and well understood qualitatively, and several empirical relationships have been developed from a combination of theory and experiment. The relationships are numerous, many of them are nonlinear, and they are interrelated. Manual solutions for streamflow by manipulation of such a set of equations are inefficient and so time consuming as to be of little value in an operational situation. Individuals and organizations responsible for streamflow forecasting have turned to watershed models as effective tools for their work. Development of such models has been facilitated by the increasing availability of large, high-speed computers.

The study contract required that the model used (1) describe the various hydrologic processes directly involved with or related to runoff and the water balance of a representative watershed, and (2) be of a type that has a capability for providing an assessment of how well remotely sensed measurements from spacecraft or aircraft can be used to study or specify the hydrologic processes occurring within the watershed. The first criterion immediately excludes the entire class of stochastic models, which obscure the cause and effect relationships among the conditions and hydrologic processes in the watershed. The model to be used in the study must therefore be a parametric model, so called because its operation

depends upon quantification of several parameters which represent coefficients and exponents in the equations implemented in the model.

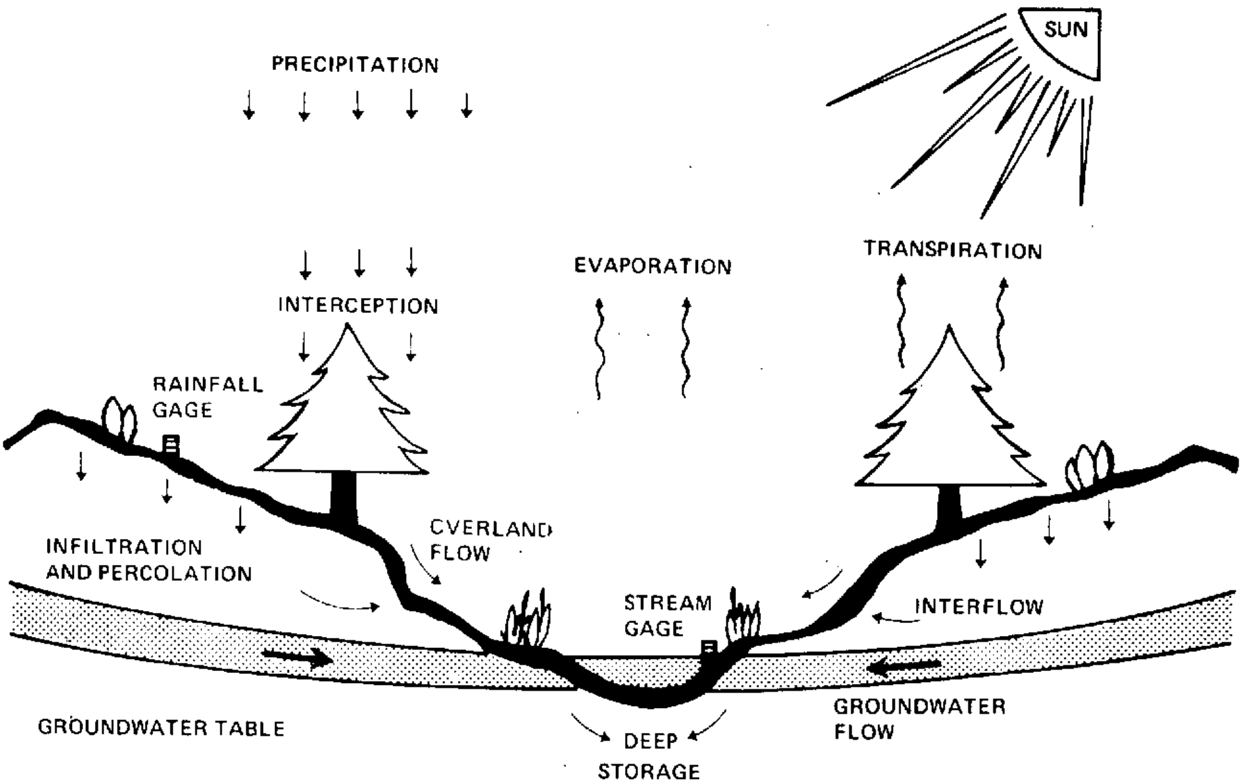


Figure 5-1. Cross Section of Idealized Rural Catchment

5.2 THE STANFORD WATERSHED MODEL (SWM)

The Stanford Watershed Model[1] is probably the best known of the parametric hydrological models and, in all its modifications, is probably the most widely used. Since it was originally published in 1962, several reports have appeared in literature describing modified versions and applications (References 2 through 8, and others). As a proven tool it was attractive to the study team for several projects dealing with applications of remote sensing to hydrology.

The Stanford Watershed Model uses a moisture accounting system to synthesize a continuous hydrograph* from the following:

1. Recorded climatological data, precipitation, evaporation, and (for snowmelt situations) temperature,

2. Measurable watershed characteristics such as drainage area and friction of the watershed in impervious surfaces, and

3. Parameters used in the computation process which are known to vary in magnitude among watersheds but have not been quantitatively tied to specific measurable watershed properties. For example, one parameter indexes the capacity of the soil of the watershed as a whole to retain water.

The third class of inputs requires a trial and error series of calibration runs to quantify a set of model parameters which will synthesize flows with acceptable accuracy.

Figure 5-2 depicts the accounting of moisture entering the watershed until it leaves by streamflow, evapotranspiration, or subsurface outflow. A series of relations, each based on empirical observation or theoretical description of a specific hydrologic process, is used to estimate rates and volumes of moisture movement from one storage category to another, in accordance with current storage states and the calibrated watershed parameters. The model routes channel inflow from the point where it enters a tributary channel to the downstream point for which a hydrograph is required.

5.3 KENTUCKY WATERSHED MODEL (KWM) AND OPSET PROGRAM

The Stanford Watershed Model was originally written in the Burroughs Computer Language (BALGOL) then in use at the Stanford Computer Center. It has subsequently been translated into Fortran IV, and a number of adaptations were introduced in one version to suit the climate and geography of Kentucky as representative of the eastern United States. In a recent (1970) research program a version of the model using an initial set of model parameter values and number of control options was developed for use with a self-calibrating streamlined version of the model. These models are referred to as the Kentucky Watershed Model (KWM) and OPSET (because it estimates the OPtimum SET of model parameters). The availability and utility of these models and reports describing them led to their use by IBM in a previous project.

*A hydrograph is simply a plot of streamflow in volume per unit time or river height as a function of time. See Reference 9, Chapter 9.

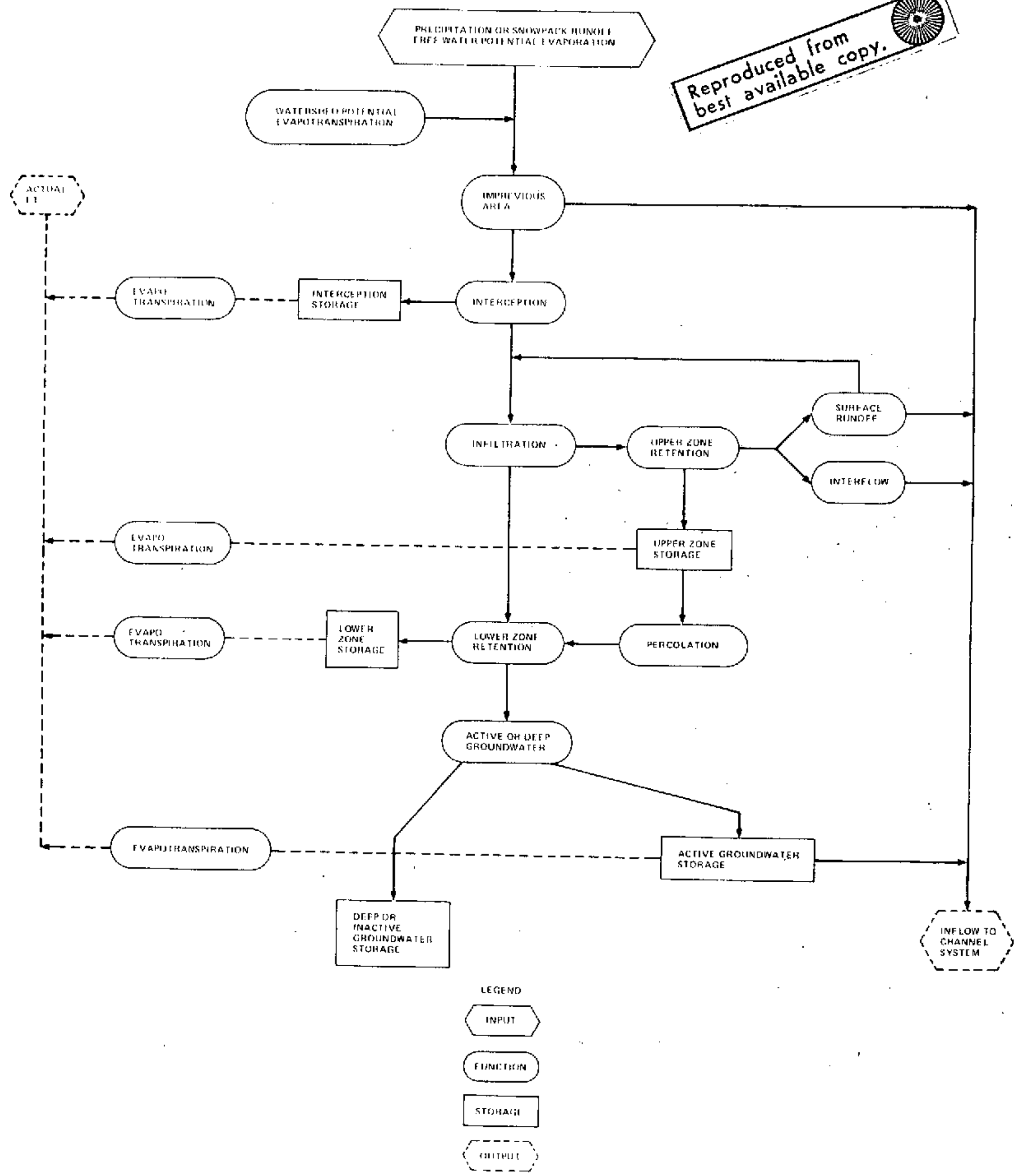


Figure 5-2. Moisture Accounting in the Stanford Watershed Model

5.3.1 KENTUCKY WATERSHED MODEL

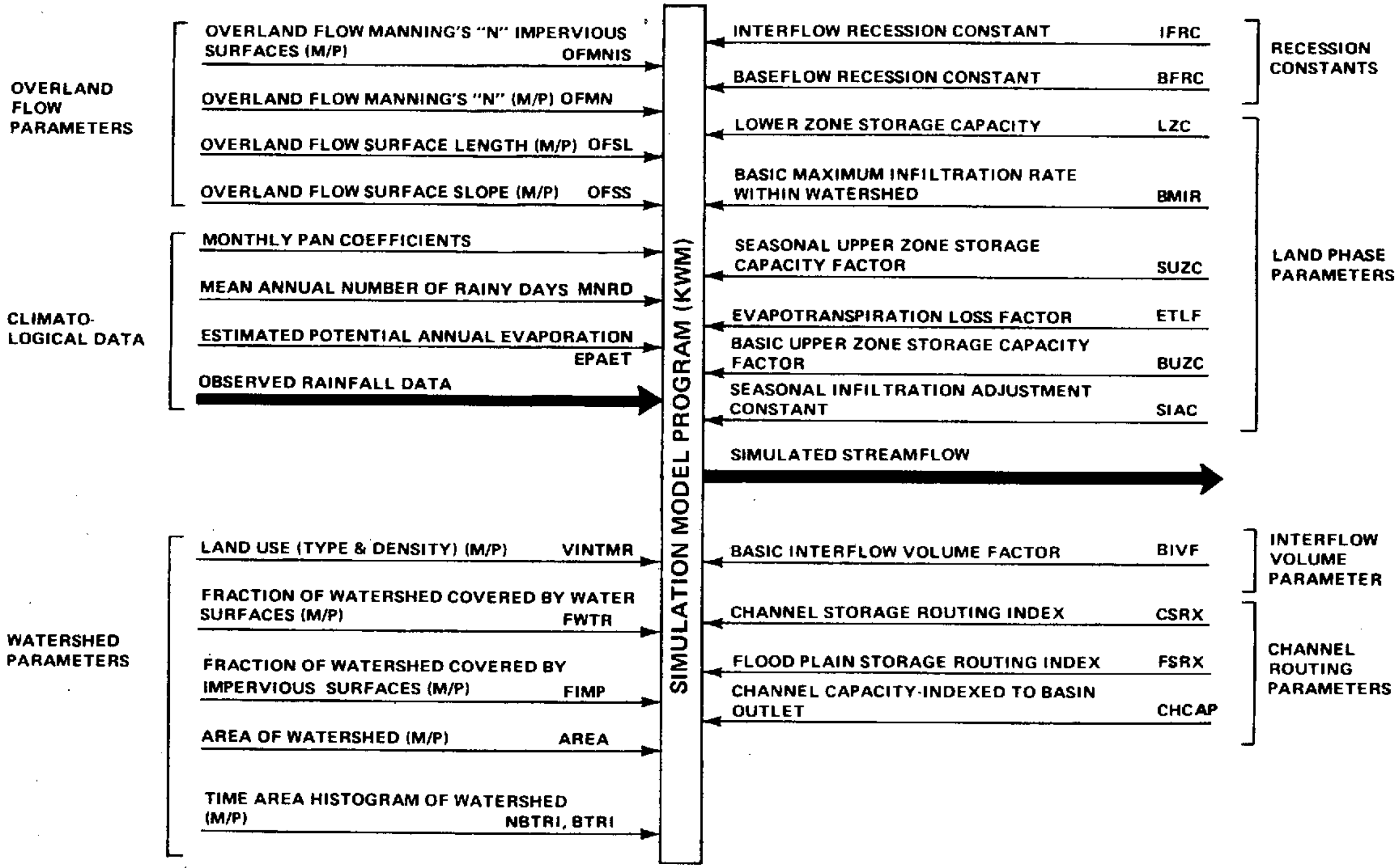
Figure 5-3 lists the principal inputs (exclusive of control options) used by the Kentucky Watershed Model to simulate streamflow. Climatological data can be obtained from precipitation records or can be hypothetical, the latter being useful in generating rainfall-runoff predictions. The inputs classed as "Overland Flow Parameters" and "Watershed Parameters" are readily obtainable from analysis and interpretation of images (maps and/or photographs). The inputs on the right side of the figure are estimated in the calibration phase by OPSET. Some additional manual calibration is necessary to develop a set of model parameters that best represent the watershed.

5.3.2 OPSET AND CALIBRATION

When a user applies a simulation model to a watershed, there are several parameters whose values he must initially guess and subsequently adjust, between trial runs of the model and comparisons of synthesized with observed flows. This trial and error calibration requires ingenuity, understanding of the sensitivity of simulated flows to specific parameter adjustments. The process is aided greatly by a thorough understanding of the hydrologic process and by the guidance published by Crawford and Linsley[1,2]. Through careful parameter adjustment, one can cause simulated flows to approximate recorded flows but never to match them exactly. Several combinations of parameter values can produce comparable results from an overall viewpoint, and the final choice may well hinge on whether a particular comparison emphasizes flood peaks, annual runoff volume, or some other hydrograph feature. The final acceptance of a set of parameters may depend heavily on subjective factors.

In developing OPSET, Liou[11] provided a tool for calibrating the KWM with a minimum of subjective decisions. The parameter optimization concept is depicted in flow chart form in Figure 5-4. The input data consists of control options and initial conditions as well as the inputs listed in Figure 5-5. A simulation is performed, one year at a time, using a "streamlined" KWM. The synthesized flows are compared with the observed flows. An objective function is used to determine when an optimum set of parameters has been found. If the best match has not been achieved, parameters are again adjusted and the simulation run again. This sequence is repeated until a satisfactory parameter set has been quantified.

Figure 5-5 also lists the 13 outputs of OPSET, in addition to simulated streamflow. (Comparison with Figure 5-3 shows the relationship to KWM.) These parameters are the most difficult to measure directly and ones to which simulated flow values are sensitive. The calibration process should be based on three separate water years for the same basin. Simulation model parameters are then derived by averaging the results of the three calibration runs. A minor modification to OPSET has been implemented to generate a more precise Base Flow Recession Constant (BFRC). As it is presently designed, OPSET estimates parameters which produce accurate simulations of major winter storms (with respect to flood peak magnitude and timing) but misses summer and autumn storm peaks by significant factors.



NOTE: M/P - MAPS AND/OR PHOTOGRAPHS

Figure 5-3. Simulation Model (KWM) Inputs and Outputs

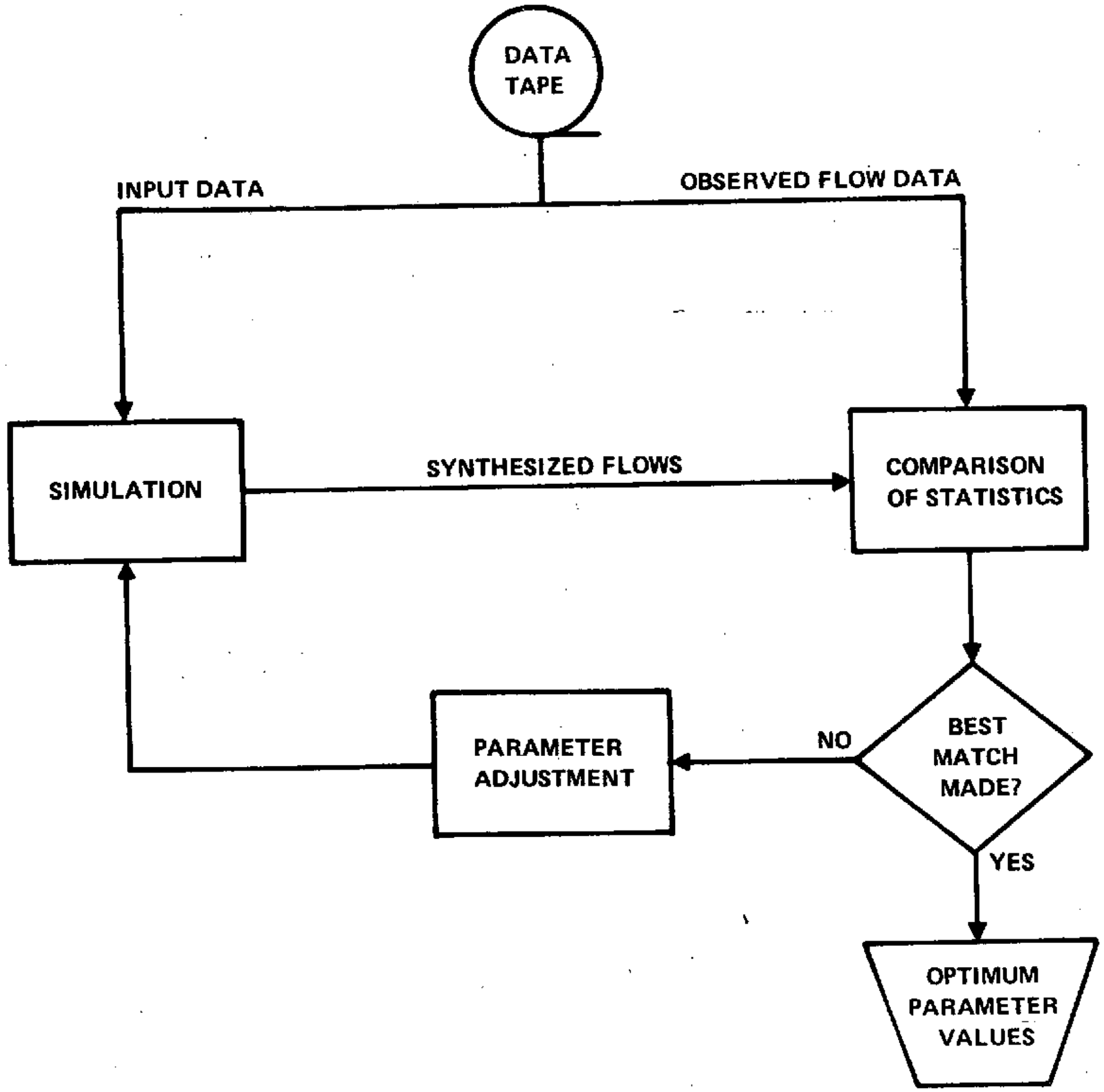
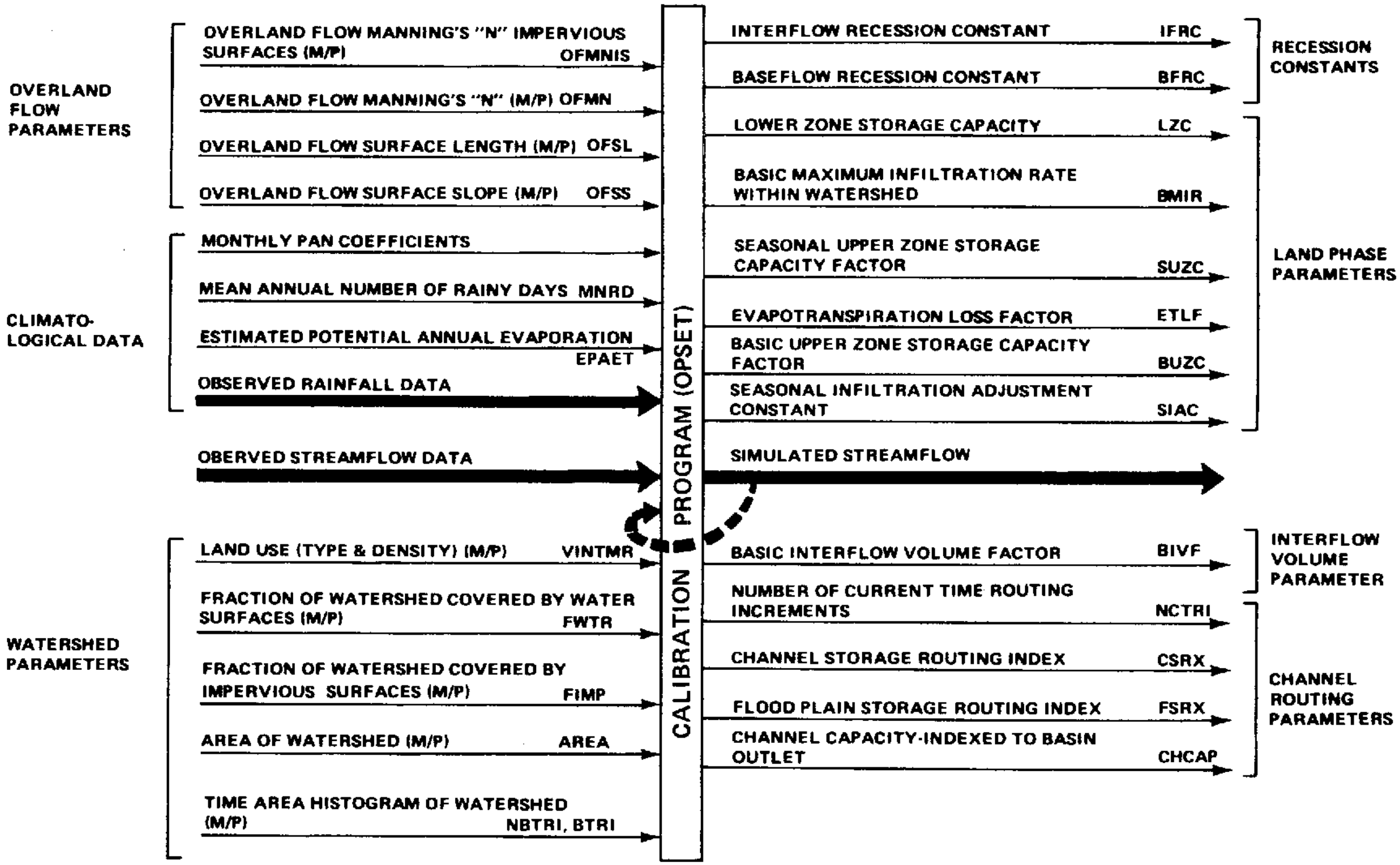


Figure 5-4. Parameter Optimization Concept



NOTE: M/P - MAPS AND/OR PHOTOGRAPHS

Figure 5-5. Calibration Program (OPSET) Inputs and Outputs

Manual adjustments are required to achieve accurate simulation in the latter. An improvement in OPSET efficiency could be achieved by modifying it to calibrate on the basis of several consecutive years rather than one year at a time.

5.4 THE NASA-IBM SYSTEM FOR SIMULATION AND ANALYSIS OF WATERSHEDS

It is common experience in the use of sophisticated simulation models that most time and manpower are not consumed by actually running the models but by (1) acquiring and formatting data and parameters, (2) setting up the program and data decks, and (3) searching through printouts to summarize and evaluate results. When sensitivity analysis was first undertaken in a previous study, involving a separate simulation run for every input or parameter perturbation, it was soon evident that the manpower, time, and data card storage requirements would quickly become exorbitant. This problem was overcome by implementing a system of computer programs and operating techniques, built around the OPSET calibration program and the Kentucky Watershed Model (KWM) to provide a high degree of automation.

The system as used in the study is illustrated in Figure 5-6. The input temporal data may be real or hypothetical. (The Tennessee Valley Authority, for instance, has an effective stochastic precipitation generator program.) The input decks for all subwatersheds are generated first; this is a compilation of the hourly precipitation, daily evaporation, reference daily discharge, daily temperature, snow cover, and selected storms for each season. If a regional watershed model is to be implemented, all the subwatershed decks are integrated into a master watershed input deck that represents the regional watershed. The master watershed deck is then committed to disk storage to permit operation from a remote terminal. Reference data sets (instead of observed historical data) can be established by a simulation run for each subwatershed. This composite reference data set will constitute the baseline for the sensitivity analysis.

5.4.1 WATERSHED MODEL DATA BASE

Simulation of a watershed requires (1) acquisition, formatting and integration of a historical data base, (2) quantification of some of the model parameters from direct observation, measurement and application of empirical relationships, and (3) calibration, the adjustment of the remaining parameters to achieve an acceptable match between simulated (synthesized) and actual streamflow. After calibration, the system may be used to predict streamflow resulting from any given precipitation event.

5.4.1.1 Historical Data

The historical data base for the system is constructed from the following types of data.

- Precipitation records - hourly and daily
- Stream stage charts - actual strip chart hydrographs

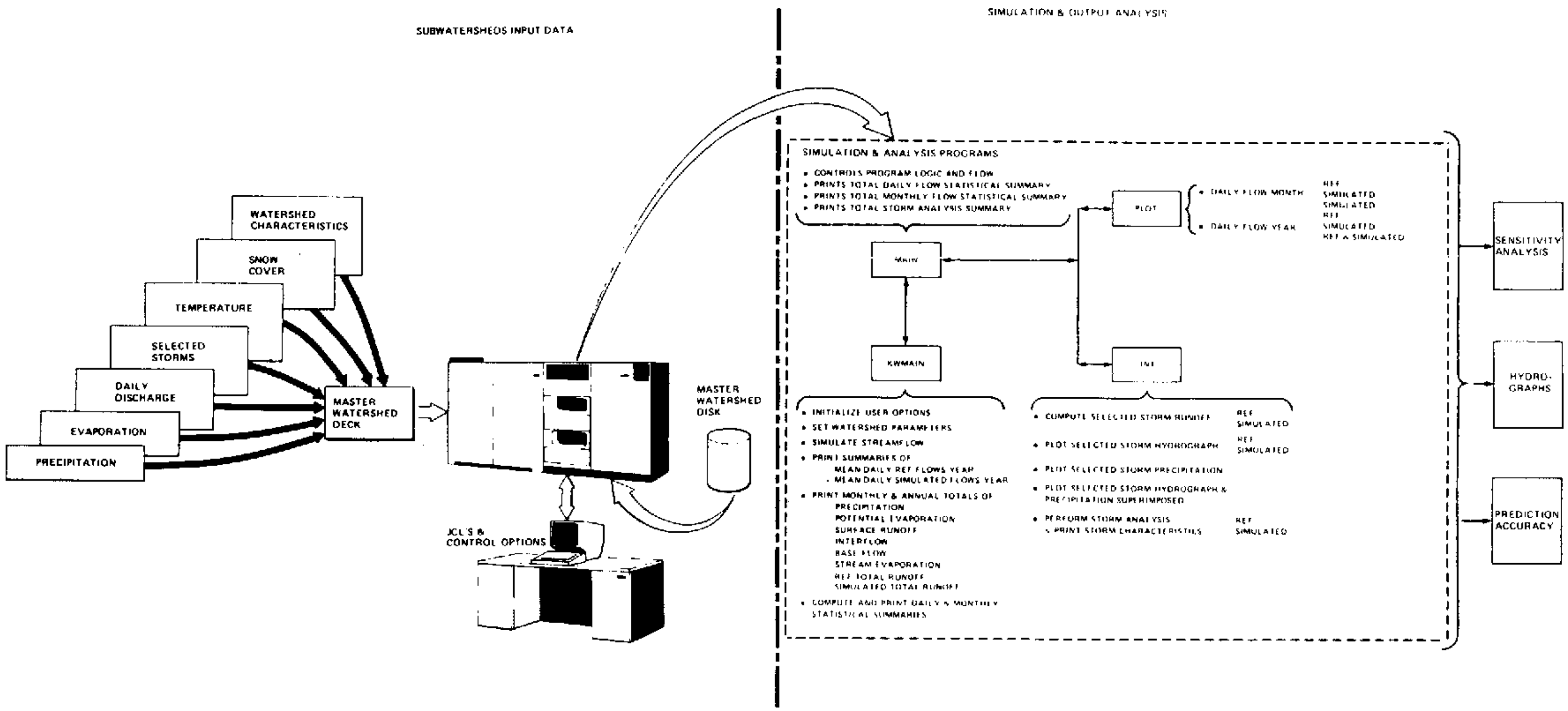


Figure 5-6. NASA-IBM System for Simulation and Analysis of Watersheds

- Rating tables for conversion of stream stage charts from height (feet) to flow rate (cubic feet per second, cfs)

- Daily streamflow (discharge) records

- Temperature records - maximum and minimum each day (used with snow routine only)

- Evaporation data - three options:

  - Daily evaporation and monthly pan coefficients; or

  - Total annual evaporation, mean annual number of rainy days and estimated potential annual evapotranspiration; or

  - Average daily evaporation values over ten-day periods through the year and monthly pan coefficients.

- Snowmelt data arrays

Data are converted from published documents or charts or magnetic tape, to digital formats suitable for input to the calibration and simulation programs.

5.4.1.1.1 Hourly Precipitation Data

Hourly precipitation data in digital form is the primary input to KWM and OPSET. In a very small watershed having its own hourly precipitation gage one can with reasonable safety assume that the gage reading applies uniformly to the entire watershed. This assumption (which is implicit in both programs) departs from reality more and more with increase in watershed size. It has been necessary to implement a method whereby several precipitation records are used to synthesize a single hourly rainfall history for each watershed or subwatershed.

The number of precipitation stations associated with any given watershed may vary from one station located 20 or 30 miles from the watershed centroid to 5 or 6 stations located within or closely adjacent to the watershed boundaries. Typically, a watershed will have one or two hourly stations, and one or more daily stations. In addition to the varying distances of these stations from the centroid, the reading time for the daily stations might be different. It is also quite likely that data will appear from the several gages in both magnetic tape and tabular formats. The latter must be manually extracted from the tables and converted to punched data card format.

The precipitation gage outputs are assigned weighting factors, using the Thiessen technique[9,13], in accordance with their physical locations relative to the basin centroid. A software program developed by IBM automatically performs the interpolation and correlation of the precipitation data. This program accepts all precipitation data, the reading time for each daily station, and the weighting factor developed from the

Thiessen Analysis, and produces an hourly percipitation record for the applicable water years associated with a given watershed. This hourly precipitation data record is then used as one of the climatological inputs required by the models.

5.4.1.1.2 Daily Discharge (Streamflow) Data

Daily discharge data is the average volume in cubic feet of water per second that flows past the stream gage during a 24 hour period. This data exists on magnetic tape and/or written tables for all stream gages in the Tennessee Valley. The data format which exists on magnetic tape must be altered to be compatible with the simulation model. Where the data exists in written tables, it is necessary to manually extract that information, convert to punched card format, and develop a listing compatible with model requirements.

5.4.1.1.3 Flood Hydrographs

For operation of the OPSET program it is necessary to select up to five flood hydrographs for each of the years for which the model is to be calibrated. This requires a manual search of precipitation and discharge records to select storms useful to the calibration. The digitized input data include the number of hydrographs chosen and three parameters related to each hydrograph: day of occurrence of the flood peak, hour of occurrence of the flood peak, and flow rate at the peak. These hydrographs parameters are essential for the OPSET program to determine watershed model routing parameters, so that total flows will represent accurate predictions, with respect to the time of occurrence of hydrograph peaks as well as the total volume of flow for a given period of time. In practice the selected storm hydrograph parameters are not available in daily discharge records. It is necessary to obtain them from the strip charts produced by the stream gage recorders. Rating tables are also digitized and stored for conversion of gage height readings into flow rate.

The procedure employed to obtain this data requires manual analysis of each strip chart and manual recording of the rise and fall of the stream gage on an hourly basis. The time frame should extend from midnight of the day in which the storm occurred until some time at which the stream height returns to or approaches its initial stage. This hourly height recording is then formatted for entry into the computer where a subroutine will fetch the appropriate rating table into memory and convert the data to cubic feet per second. This flood hydrograph data is then in a usable form when required by the simulation model.

5.4.1.1.4 Evaporation Data

Evaporation data appear in Climatological Data publications of the National Weather Service. Unfortunately, the number of pan evaporation stations is to limited to provide complete coverage. The nearest evaporation station may be as much as 100 miles from the watershed. Additionally, the station may be associated with a large lake or reservoir

which has evaporation rates different from those of an interior watershed in a predominately mountainous region. Preparation of the evaporation data is similar to that for daily discharge data in that the rates and pan evaporation coefficients are read from published tables, punched onto cards, and a computer-compatible listing generated for the identified watershed.

The nearest evaporation pan may be too far away for the daily weather-related fluctuations in evaporation totals to be indicative of conditions over the watershed. In that case, or if one simply wishes to avoid having to compile daily evaporation totals, pan evaporation totals may be read as average values over fixed ten-day periods. The model has been programmed to adjust the potential evaporation total during rainy days (rainfall equal to or greater than 0.01 inch) to half what it would be if no rain occurred.

A second alternative is available, useful where a large number of watersheds are to be modeled in an area where a single evaporation pan is used. In this case (as in the regional watershed model), estimates of the potential average annual lake evaporation and the mean annual number of rainy days may be used. A control option causes a special program to calculate measurable rainfall.

5.4.1.1.5 Temperature Data

Minimum and maximum temperature readings are required for each day of the water year, if the snowmelt routine is used. Since air temperatures vary over a watershed, recorded temperatures, preferably from a station within the basin, are adjusted by the main simulation program to mean basin elevation. The temperature data are published by the National Weather Service.

5.4.1.1.6 Snowmelt Data Arrays

If snow and snowmelt are important processes in the watershed modeled, the snowmelt subroutine is used, and the following data arrays are required.

- FIRR - The fraction of incoming radiation reflected by a snow surface as a function of age. This array of 15 values is used to adjust snowmelt rates as snow surface albedo changes with age.

- RICY - Radiation incidence over the calendar year. The RICY data array is an array of 37 values each representing an adjustment factor to the snowmelt rate for each 10-day period during the calendar year. In the snowmelt model of Anderson and Crawford,[3] which was used in this study, snowmelt is calculated on the basis of a degree day heat input to the snow pack.

- DPSE - Dated potential snow evaporation. In the Stanford Snowmelt Model, evapotransipration and evaporation from the snow surface are considered separately. The DPSE data array is the data source for snow evaporation and represents daily snow evaporation for 10-day periods during the water year. In the calcuations, snow evaporation

does not occur if the daily minimum temperature is greater than 32^{o} or if the snowpack total water content is less than the daily potential snow evaporation.

5.4.1.2 Parameters

Proper operation of the simulation model requires selection of some 16 control options and 41 parameters, in addition to the historical data and observed streamflow records (essential for calibration and for comparison of simulation results with observations). The parameters are listed below. The methods of quantification are described elsewhere in the literature[11, 12, 14].

Snowmelt Parameters

BDDFSM - Basic degree day factor for snowmelt
SPBFLW - Snowpack basic maximum fraction in liquid water
SPTWCC - Snowpack minimum total water for complete basin cover
SPM - Snow precipitation multiplier
ELDIF - Elevation difference between base temperature station and mean basin elevation
XDNFS - Index density of new fallen snow
FFOR - Fraction of the watershed forested
FFSI - Fraction of snow intercepted
MRNSM - Maximum rate of negative snowmelt (chilling)
DSMGH - Daily snowmelt from ground heat
PXCSA - Precipitation index for changing snow albedo

Watershed Parameters

RGPMB - Recording gage precipitation multiplier
AREA - Area of the watershed
FIMP - Fraction of watershed covered by impermeable surfaces
FWTR - Fraction of watershed covered by water surfaces

Soil Water Parameters

VINTMR - Vegetation interception maximum rate
BUZC - Basic upper zone storage capacity factor
SUZC - Seasonal upper zone storage capacity factor
LZC - Lower zone storage capacity
ETLF - ET loss factor
SUBWF - Subsurface water flow out of the basin
GWETF - Ground water evapotranspiration factor
SIAC - Seasonal infiltration adjustment factor
BMIR - Basic maximum infiltration rate with basin
BIVF - Basic interflow volume factor

Overland Flow and Interflow Parameters

OFSS - Overland flow surface slope
OFSL - Overland flow surface length

OFMN - Manning's n for overland flow
OFMNIS - Manning's n for impervious surface
IPRC - Interflow recession constant

Channel Routing and Groundwater Parameters

CSRX - Channel storage routing index
FSRX - Flood plain storage routing index
CHCAP - Channel capacity indexed to basin outlet
EXQPV - Exponent of flow proportional to velocity
BFNLR - Base flow nonlinear recession adjustment factor
BFRC - Base flow recession constant

Starting Moisture Values as of October 1

GWS - Current groundwater storage
UZS - Current upper zone storage
LZS - Current lower zone storage
BFNX - Current value of base flow recession index
IPS - Current interflow storage

5.4.1.3 Calibration

The calibration process has been summarized previously in Paragraph 5.3.2. The activities normally involved in calibration are shown in Figure 5-7. Data pertaining to the watershed to be calibrated are fed into the OPSET program, which is then run to estimate a set of model parameters. This step gets the task "into the ball park." A simulation is then run using KWM and the IBM analysis/evaluation routines. Simulation accuracy is evaluated with respect to total annual runoff, monthly flow, daily flow, statistical indices, and selected storm hydrograph characteristics. Based on these evaluations, parameters are adjusted, and a new simulation run, followed by another evaluation. This process goes through several iterations until simulated flow matches observed flow with acceptable accuracy in all criteria of interest to the analyst. The choice of parameters to adjust, direction and magnitude of the adjustments depend upon the judgment of the analyst. Sensitivity analyses have produced invaluable guidance to the manual-adjustment activity, reducing the subjectivity and eliminating the require that the analyst be skilled in hydrology.

At present, it is necessary to repeat the same calibration for the same same basin for two additional water years and then average parameter values from the three sets of results before undertaking simulations for other water years. This procedure could be improved by modifying OPSET to operate on up to four water years.

The full calibration procedure was not necessary in this study and consequently was not used. All watersheds modeled in the study had previously been modeled. Calibrated parameter values were available for both small watersheds and all the subwatersheds of the regional watershed. It was necessary to verify that the models would run with reasonable

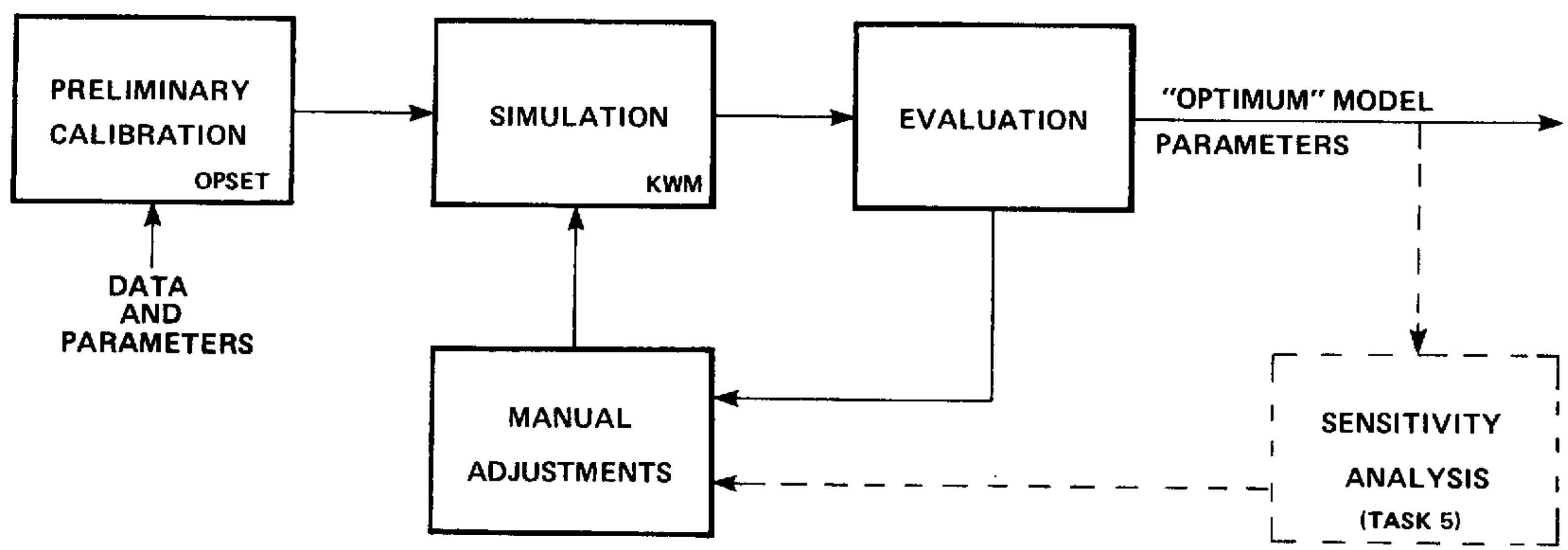


Figure 5-7. Calibration Methodology

accuracy but not to "fine tune" the parameters. Additionally, the watersheds modeled were allowed to be hypothetical but had to be realistic. Several debugging and verification runs were necessary to assure that the snowshed and regional watershed models would run in the IBM system.

Totally accurate hypothetical watershed models were created by (1) selecting the water year for which each model ran best; (2) running each model with its "best set" of parameters and input data from its best water year; (3) naming the synthesized hourly and daily streamflow arrays produced by this run the "reference" streamflow; (4) replacing the observed streamflow data in the data base by the reference streamflow; and (5) verifying that the "reference" configuration of the model (using the reference set of parameters, formerly called the "best set") does indeed simulate the reference streamflow exactly.

5.4.1.4 Integrated Data Base

After reference configurations have been established and reference streamflow generated, the entire data base is transferred to an integrated Master Watershed Data Bank on tape. For efficient operation in performing a series of simulation runs, the integrated watershed data base is transferred to disk storage, as indicated in Figure 5-6.

5.4.2 SIMULATION PROGRAM OUTPUTS

There are a variety of outputs available from the simulation program in the NASA-IBM system. The operator and analyst can choose those which best suit his needs from the following.

- A tabulation of hourly synthesized streamflow, with daily values for the following:
  - peak flow and time of peak
  - snowpack depth
  - snow total moisture density
  - snow albedo index
  - total accumulated negative snowmelt
  - snowpack liquid water content
- A table of monthly annual totals, similar to that shown in Figure 5-8.
- A yearly statistical summary, as shown in Figure 5-9.
- A table of mean daily reference streamflow, with monthly and annual totals.

YEARLY STATISTICAL SUMMARY				
	MONTHLY		DAILY	
	REFERENCE	SIMULATED	REFERENCE	SIMULATED
MEAN	9914.90	10085.50	325.06	330.65
MAXIMUM	32757.35	34005.84	5430.90	6017.22
VARIANCE	110596272.00	117735280.00	429042.81	601067.06
STANDARD DEVIATION	10516.48	10850.59	655.01	775.29
SUM OF (REFERENCE - SIMULATED)	-2047.31		-2047.32	
ROOT SUM SQUARE	2630.77		3268.44	
SUM SQUARED	0.39		54.14	
SUM SQUARED (IBM METHOD)	0.31		48.38	
CORRELATION COEFFICIENT	0.9979		0.9855	

Figure 5-8. Example of Yearly Statistical Summary

S U M M A R Y   O F   M O N T H L Y   A N D   A N N U A L   T O T A L S

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
PRECIPITATION	0.100	4.580	3.790	6.320	3.570	11.240	9.140	3.670	3.810	7.010	3.090	1.910	58.230 IN
EVP/TRAN-NET	0.317	1.106	0.412	0.451	1.034	1.584	2.583	3.646	3.082	4.368	3.320	1.810	23.714 IN
-POTENTIAL	2.296	1.155	0.412	0.451	1.034	1.584	2.772	4.753	3.836	5.024	4.545	2.891	30.753 IN
SURFACE RUNOFF	0.000	0.347	0.123	3.431	0.834	5.921	3.314	1.405	0.549	1.337	0.232	0.015	17.510 IN
INTERFLOW	0.0	0.0	0.010	0.306	0.268	0.917	1.017	0.214	0.000	0.043	0.0	0.0	2.774 IN
BASE FLOW	0.000	0.212	0.652	1.490	1.230	2.133	2.346	1.315	0.564	1.063	0.530	0.131	11.666 IN
STREAM EVAP.	0.000	0.001	0.000	0.000	0.001	0.002	0.003	0.005	0.004	0.005	0.005	0.003	0.028 IN
TOTAL RUNOFF(SIM)	0.000	0.558	0.785	5.227	2.331	8.969	6.674	2.929	1.109	2.438	0.758	0.144	31.922 IN
TOTAL RUNOFF(REF)	0.0	0.370	0.791	4.798	2.434	8.640	6.683	3.248	1.100	2.269	0.861	0.188	31.382 IN
REFERENCE TOTALS	0.0	1401.6	3000.0	18189.9	9228.8	32757.4	25336.6	12314.6	4170.2	8604.3	3264.1	711.6	118978.8 CFS
SIMULATED TOTALS	0.0	2114.8	2978.0	19815.4	8837.7	34005.8	25302.3	11104.3	4206.3	9244.3	2873.1	544.3	121026.1 CFS

BALANCE -0.0117 INCHES

MONTHLY FLOW CORRELATION COEFFICIENT 0.9979
MEAN DAILY FLOW CORRELATION COEFFICIENT 0.9855

Figure 5-9. Example of Monthly and Annual Totals

- A table of mean daily simulated streamflow, with monthly and annual totals.
- A table of monthly moisture storages and indices.
- A table of flow duration and error statistics.
- A list of the 20 highest clock hour rainfall events in the water year.
- A list of the 20 highest clock hour overland flow runoff events in the water year.
- A table of daily soil moisture.
- A comparison table of storm events, reference and simulated, with respect to peak flow, time of peak, and runoff, one table per storm event.
- Total daily and monthly statistical summary.
- Print-plots for total year, each month and each storm event.
- Tapes of data for SC-4020 plot outputs for total year, each month and each storm event.

Examples of the outputs are included in Appendices A, B, and C.

5.5 WATERSHED SIMULATION IN THIS STUDY

The system described in the previous paragraphs is directly applicable to the Town Creek and Alamosa Creek watersheds. Application to a regional watershed required additional programming.

In order to analyze a regional watershed and maintain a realistic configuration the watershed must be subdivided into subareas. The Hydrology Office of the National Oceanic and Atmospheric Administration (NOAA) has lately developed and proven several subroutines which will synthesize a complete river system from a number of "small" watersheds.[8] The size of the system that can be simulated is virtually unlimited. During a single pass through the programs, the system size is controlled by the dimensions of the climatological input array, model parameter array and channel inflow (runoff from the land phase) array plus the dimensions of the channel reach parameter and storage array, and the simulated and observed flow array. However, by recycling the program and using downstream outflows from one pass as upstream inflows for the next, a very large river system can be simulated.

A representative stream system is shown in Figure 5-10 to illustrate the flowpoint numbering system used in the programs. In this illustration, flow is being computed at seven points during this pass of the program; there are also two upstream inflows from outside the area. For points where flow is computed, the flowpoint number must be greater than that of the points upstream. Then flow needed as inflows to a local area will have previously been computed, since the program computes flows in sequential order. Since upstream inflows from outside the area have been computed previously, they are assigned numbers at the end of the string and can provide the rule that upstream inflow points must have a flowpoint number less than the downstream flowpoint.

The runoff from the land phase of the hydrologic cycle (channel inflow) is computed independently from the channel system. To unite the two systems, it is necessary to assign to each channel reach the area or area from which it is to receive channel inflow.

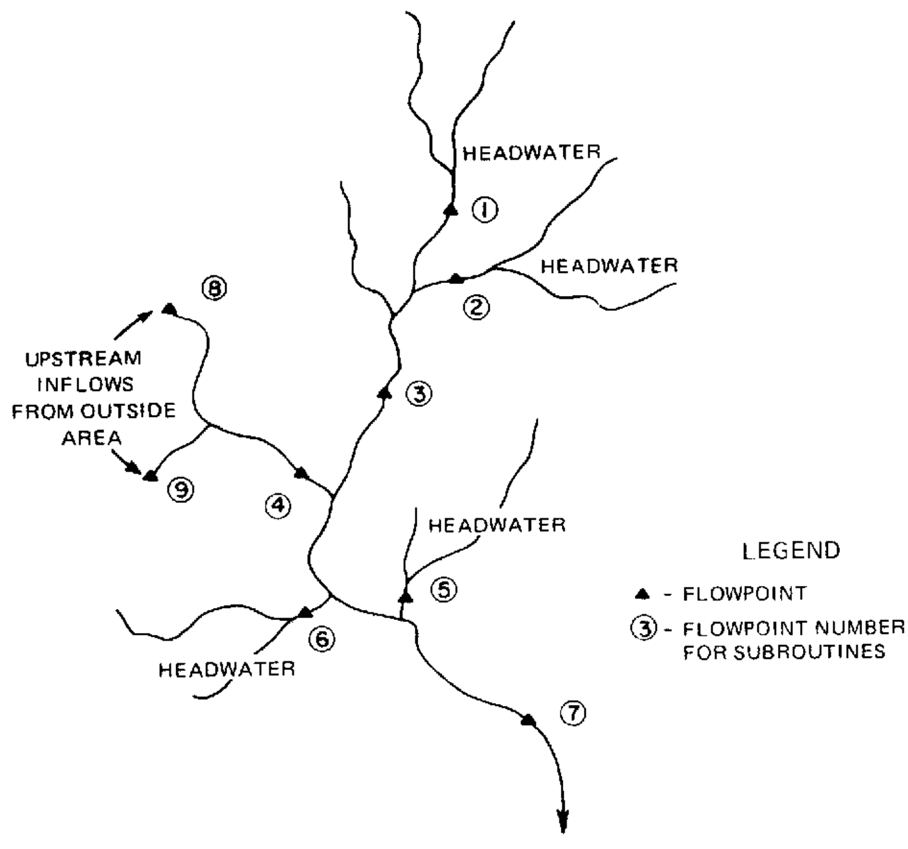


Figure 5-10. Flowpoint Numbering for River System Simulation

Examples of simulation run results for the Town Creek, Alamosa Creek and Pearl River watersheds are shown in Appendices A, B, and C, respectively.

5.6 REFERENCES, SECTION 5

1. Crawford, Normal H., and Linsley, R. K. Digital Simulation in Hydrology: Stanford Watershed Model IV. Stanford, California: Stanford University, Department of Civil Engineering, Technical Report No. 39, July 1966.

2. Hydrocomp International. "HSP Operations Manual," Palo Alto, California, 1969.

3. Anderson, E. A., and Crawford, N. H. The Synthesis of Continuous Snowmelt Hydrographs on a Digital Computer. Stanford, California: Stanford University, Department of Civil Engineering, Technical Report No. 36, 1964.

4. Hydrocomp International. "Simulation of Continuous Discharge and Stage Hydrographs in the North Branch of the Chicago River," Palo Alto, California, 1970.

5. James L. Douglas. Economic Analysis of Alternative Flood Control Measures. Lexington: University of Kentucky, Water Resources Institute, Research Report No. 16, 1968.

6. Ligon, James T., Law, Albert G., and Higgins, Donald H. Evaluation and Application of a Digital Hydrologic Simulation Model. Clemson, South Carolina: Clemson University, Water Resources Research Institute, Report No. 12, November 1969.

7. Lumb, Alan Mark. Hydrologic Effects of Rainfall Augmentation. Stanford, California: Stanford University, Department of Civil Engineering, Technical Report No. 116, November 1969.

8. Hydrologic Research Laboratory, National Oceanic and Atmospheric Administration, National Weather Service, United States Department of Commerce. National Weather Service River Forecast System Forecast Procedures, NOAA TM NWS-HYDRO-14, Washington, D. C., December 1972.

9. Linsley, Ray K., Kohler, Max A., and Paulhus, Joseph L. H. Hydrology for Engineers. New York: McGraw-Hill Book Co., 1958.

10. James, L. Douglas. An Evaluation of Relationships between Streamflow Patterns and Watershed Characteristics through the Use of OPSET: A Self-Calibrating Version of the Stanford Watershed Model. Lexington: University of Kentucky, Water Resources Institute, Research Report No. 36, 1970.

11. Liou, Earnest Y. OPSET: Program for Computerized Selection of Watershed Parameter Values for the Stanford Watershed Model. Lexington: University of Kentucky, Water Resources Institute, Research Report No. 34, 1970.

12. Ross, Glendon A. The Stanford Watershed Model: The Correlation of Parameter Values Selected by a Computerized Procedure with Measurable Physical Characteristics of the Watershed. Lexington: University of Kentucky Water Resources Institute, Research Report No. 35, 1970

13. Chow, Ven Te (ed.). Handbook of Applied Hydrology. New York: McGraw-Hill Book Company, 1964.

14. Striffler, W. D., User Manual for the Colorado State University Version of the Kentucky Watershed Model, Colorado State University, September 1973.

SECTION 6

SENSITIVITY ANALYSIS

6.1 METHODOLOGY

The inputs to the Sensitivity Analysis Task are a set of watershed parameters, climatological data, and a "reference" streamflow record from the modeling task. Sensitivity Analysis consists of (1) changing a model parameter or input, (2) running the simulation model and printing out the performance indices which indicate the deviations between the reference record and the simulation output, (3) evaluating the results and then repeating the steps after selecting another input perturbation.

The total number of simulation runs was 442: 166 for Town Creek, 137 for Alamosa Creek, and 139 for Pearl River. In the case of the regional watershed model, a printout was produced for every one of the 12 subwatersheds. The study team analyzed a total of 1971 printouts and an uncounted number of plots. Each one of 46 different inputs and parameters was tested at from two to ten different perturbed values. Not all were tested on all watersheds; the snowmelt parameters, for example, do not apply to the Town Creek and Pearl River models.

6.1.1 PERFORMANCE INDICES

The performance of a watershed simulation model may be judged differently by different potential users, each with a particular application in mind. One may be interested in the effect of a parameter variation on low flow, another on total annual flow, a third on magnitude and timing of hydrograph peaks and total runoff resulting from storm events in a particular season. Varying a particular parameter may have a pronounced effect on some of these indices and not on others. It was therefore deemed advisable in the sensitivity analysis task to provide in the tabular summary outputs indicators of the following:

- Storm runoff and percent variation from reference runoff for a selected storm event in each season, for each headwater SWS of the regional watershed and the two small watersheds.
- Monthly runoff for October, January, April and August and percent variation from reference for each of those months for the regional watershed.
- Variation from reference low flow.
- Variation from reference annual flow.

6.1.2 SENSITIVITY ANALYSIS TABULATIONS

Unit sensitivity is defined as (percent change in performance index) ÷ (percent change in parameter). It was adopted to provide a basis for comparison of the sensitivities of the models to variations in its several different parameters. It departs from corresponding concepts in perturbation theory because many of the percentage perturbations used in the study are large, and the sensitivity curves are non-linear. The concept served well as an initial indicator of the relative influences of the parameters.

Each simulation run was assigned an identification number, and its results were entered into two tables, examples of which are shown in Tables 6-1 and 6-2. In table Type I, one for each of eight watersheds, the effects of all perturbations of a given parameter in one basin model are summarized. In table Type II, the effects of a single parameter perturbation in eight basin models are shown. Tables have been prepared for 26 parameters and are included in this volume under heading 6.3.

6.1.3 SENSITIVITY PLOTS

The numerical results, in terms of unit sensitivities, showed considerable variation from one performance index to another within a given basin as well as from one basin to another for a given performance index; the former are largely seasonal effects. A better assessment of results was achieved by constructing sensitivity plots like those appearing in Figure 6-1. In each of them, the abscissa scale is the percentage variation in the input parameter, and the ordinate scale is the percentage variation in performance indices (runoff). Plots have been prepared in several combinations for 26 parameters and are included in this volume under heading 6.4.

6.2 SUMMARY OF RESULTS

Of all the parameters and inputs tested and analyzed in the study, 26 are listed in Table 6-3, which shows the permissible tolerances found for each parameter, the effect of its variation on runoff, its relation to watershed geomorphology, how it can be determined from remote-sensed data or other data source, and the image resolution corresponding to the permissible tolerance, if applicable.

The parameters and inputs tested but not listed in Table 6-3 were found not to produce a meaningful result when varied or to be of negligible effect. An example of the first is the area of the watershed itself. Changing the area by a given factor simply changed the runoff by the same factor for all basins in all seasons. An example of the second (no effect) is the overland flow roughness coefficient (Manning's "n") for impervious surfaces, designated OFMNIS. The range of values it is normally assigned is from 0.013 to 0.017, and varying it from 0.001 (-93%) to 0.5 (+3233%) in the regional watershed model produced negligible change in simulated runoff. This is logical, because in every watershed modeled, the portion of basin area covered by impervious surfaces is less than 10% (as it would be expected

TABLE 6-1

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SMALL WATERSHED 365 SQ. KM.

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

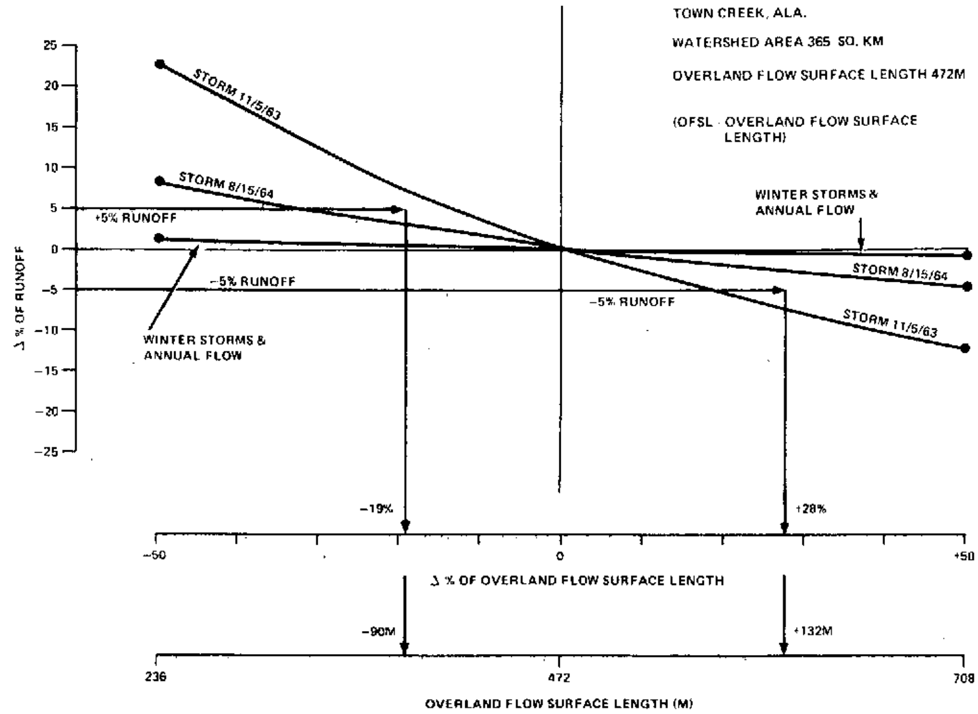
RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
S000	0.002	−100	Δ% OF R/O	−60.9	−4.2	−4.4	−39.5	+3.95	−7.15
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6 SIM = 7.9	STORM U/S F + 0.609 W + 0.042 SP + 0.044 SU + 0.395
			REF. R/O (IN)	0.46	2.41	2.03	0.43		
			PERT. R/O (IN)	0.18	2.31	1.94	0.26		
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		
D010	0.05	−50	Δ% OF R/O	−32.6	−2.1	−2.5	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6 SIM = —	STORM U/S F + 0.652 W + 0.042 SP + 0.050 SU ———
			REF. R/O (IN)	0.46	2.41	2.03	0.43		
			PERT. R/O (IN)	0.31	2.36	1.98	———		
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		
S012	0.20	+100	Δ% OF R/O	+63.0	+4.6	+4.9	+41.9	−1.06	+ 7.31
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6 SIM = 7.2	STORM U/S F + 0.630 W + 0.046 SP + 0.049 SU + 0.419
			REF. R/O (IN)	0.46	2.41	2.03	0.43		
			PERT. R/O (IN)	0.75	2.52	2.13	0.61		
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		
D013	0.30	+200	Δ% OF R/O	+126.1	+8.7	+9.9	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6 SIM = —	STORM U/S F + 0.631 W + 0.044 SP + 0.050 SU ———
			REF. R/O (IN)	0.46	2.41	2.03	0.43		
			PERT. R/O (IN)	1.04	2.62	2.23	———		
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		

Table 6-2. Example of Sensitivity Analysis Tabulation, Table Type II

SENSITIVITY ANALYSIS OF FIMP -100% PERTURBATION (0.10 REFERENCE)
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID S000			Δ% OF R/O	-60.9	-4.2	-4.4	-39.5	+3.95	-7.15
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.46	2.41	2.03	0.43	REF = 7.6	F +0.609
			PERT. R/O	0.18	2.31	1.94	0.26	SIM = 7.9	W +0.042
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SP +0.044 SU +0.395
RUN ID 01			Δ% OF R/O	-63.9	-35.7	-19.1	-72.3	0.0	-13.9
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.077	0.058	1.106	0.124	REF = 3.0	F +0.636
			PERT. R/O	0.028	0.037	0.895	0.034	SIM = 3.0	W +0.357
			REF (R/F/R/O)	38.83	—	1.61	8.79		SP +0.191 SU +0.723
RUN ID RW06			Δ% OF R/O	-64.7	-4.9	-13.0	-70.0	-53.8	-16.0
			Δ% OF MONTHLY R/O	OCT -44.1	JAN -5.7	APR -7.8	AUG -67.2	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.17	1.02	0.54	0.10	REF = 1340	F +0.647
			PERT. R/O	0.06	0.97	0.47	0.03	SIM = 619	W +0.049
			REF. MONTHLY R/O	0.247	3.785	2.743	0.479		SP +0.130 SU +0.700
RUN ID RW06			Δ% OF R/O	-83.3	-8.0	-20.4	-79.2	+3.0	-15.0
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.24	1.74	0.93	0.24	REF = 33	F +0.833
			PERT. R/O	0.04	1.60	0.74	0.05	SIM = 34	W +0.080
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SP +0.204 SU +0.792
RUN ID RW06			Δ% OF R/O	-85.7	-4.4	-18.0	-75.9	+4.6	-12.5
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.28	2.25	0.61	0.29	REF = 22	F +0.857
			PERT. R/O	0.04	2.15	0.50	0.07	SIM = 23	W +0.044
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		SP +0.180 SU +0.759
RUN ID RW06			Δ% OF R/O	-90.0	-2.6	-12.0	-90.5	+25	-9.9
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.10	1.94	1.00	0.21	REF = 4	F +0.900
			PERT. R/O	0.01	1.89	0.88	0.02	SIM = 5	W +0.026
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SP +0.120 SU +0.905
RUN ID RW06			Δ% OF R/O	-82.4	-8.8	-16.4	-72.7	+2.6	-13.8
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.17	1.70	0.73	0.44	REF = 39	F +0.824
			PERT. R/O	0.03	1.55	0.61	0.12	SIM = 40	W +0.088
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		SP +0.164 SU +0.727
RUN ID RW06			Δ% OF R/O	-61.1	-8.9	-20.6	-75.0	0.0	-17.1
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.18	0.79	0.63	0.04	REF = 9	F +0.611
			PERT. R/O	0.07	0.72	0.60	0.01	SIM = 9	W +0.089
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SP +0.206 SU +0.750

OVERLAND FLOW SURFACE LENGTH STUDY SMALL WATERSHED



FORESTED AREA STUDY SMALL WATERSHED

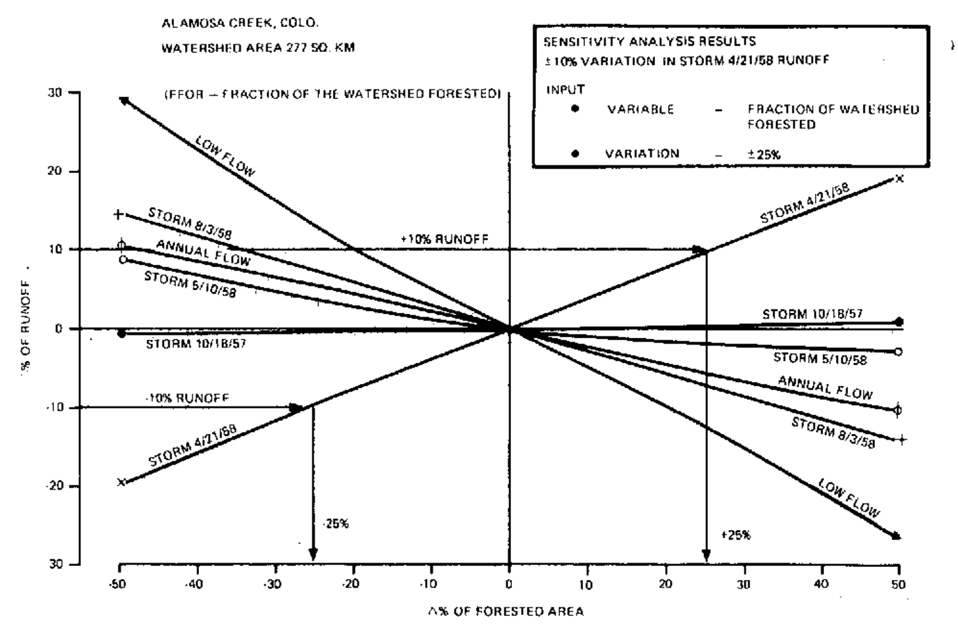


Figure 6-1. Examples of Sensitivity Plots

Table 6-3. Permissible Tolerances and Resolutions

INPUT OR PARAMETER	PERMISSIBLE TOLERANCES %	EFFECT ON SIMULATED RUNOFF,%	RELATIONSHIP TO WATERSHED GEO-MORPHOLOGY	DERIVATION FROM REMOTE-SENSED DATA OR OTHER SOURCE	REQUIRED IMAGE RESOLUTION,M
IMPERVIOUS PORTION OF BASIN AREA	±1.4 OF BASIN AREA	±10 (FALL)	ROCK OUTCROP-PINGS, STREETS, HIGHWAYS, URBAN AREAS	IMAGE ANALYSIS; LAND USE CLASSIFICATION	100
WATER SURFACE PORTION OF BASIN AREA	+1.5, −1.6 OF BASIN AREA	±10 (FALL)	LAKES, PONDS, RIVERS	IMAGE ANALYSIS; LAND USE CLASSIFICATION	120
VEGETATIVE INTERCEPTION MAXIMUM RATE (VINTMR)	+95 −60	−5 +5 (SUMMER)	TYPE & DENSITY OF VEGETATIVE COVER, TREES, MEADOWS, ETC.	IMAGE DATA CLASSI-FICATION AND INTERPRETATION	200
UPPER ZONE STORAGE CAPACITY (BUZC)	+50 −50	−2.5 +2.5 (SUMMER)	SOIL PERMEABILITY, OVERLAND SLOPES, FOREST COVER	INFERENCE FROM LAND USE CLASSIFICATION	500
SEASONAL FACTOR UPPER ZONE CAPACITY (SUZC)	+70 −30	−20 +20 (SUMMER)	SOIL PERMEABILITY, VEGETATIVE COVER	INFERENCE FROM LAND USE CLASSIFICATION	100
LOWER ZONE STORAGE CAPACITY (LZC)	+14 −15	−10 +10 (WINTER)	SOIL ASSOCIATION, VEGETATIVE TYPES AND COVERAGE DENSITY	INFERENCE FROM LAND USE CLASSIFICATION	100
EVAPOTRANS-PIRATION LOSS FACTOR (ETLF)	+15 −15	−10 +10 (SUMMER)	VEGETATIVE COVER, TYPE & DENSITY: ESPECIALLY FOREST	IMAGE ANALYSIS; LAND USE CLASSIFICATION	100
SEASONAL INFIL-TRATION ADJUST-MENT FACTOR (SIAC)	+20 −22	−1 +1 (SUMMER)	VEGETATIVE COVER, SOIL ASSOCIATION	INFERENCE FROM LAND USE CLASSI-FICATION (DOUBTFUL; CALIBRATION NEEDED	300
BASIC MAXIMUM INFILTRATION RATE (BMIR)	+35 −28	−5 +5 (WINTER)	SOIL PERMEABILITY, VEGETATIVE TYPE AND DENSITY	INFERENCE FROM LAND USE CLASSI-FICATION	150
MEAN OVERLAND SURFACE SLOPE (OFSS)	+200 −67	+0.5 −0.5 (WINTER)	TOPOGRAPHY	DIRECT MEASURE-MENT IF RELATIVE ELEVATION IS AVAILABLE	100 HORI-ZONTAL, 20 VERTICAL
MEAN OVERLAND SURFACE LENGTH (OFSL)	+40 −35	−0.3 +0.3 (WINTER)	AVERAGE DISTANCE FROM RANDOMLY SELECTED POINTS TO NEAREST STREAMS	DIRECT MEASURE-MENT IF STREAM-LINES ARE DISCERNABLE	500
OVERLAND FLOW ROUGHNESS COEFFICIENT (OFMN)	+80 −50	−0.5 +0.5 (WINTER)	SURFACE TYPE; FOREST AND VEGE-TATIVE COVER	IMAGE ANALYSIS; LAND USE CLASSIFICATION	500
PRECIPITATION MULTIPLIER (RGPMB)	+3 −3	+10 −10 (FALL)	ADJUSTS FOR BIAS IN PRECIPITATION GAGE DATA; NOMINAL VALUE IS 1.0	ADJUST FIELD INSTRUMENT READINGS FOR BETTER SIMULATION	+3% IN PRECIP. MEASURE (BIAS)

Table 6-3. Permissible Tolerances and Resolutions (Continued)

INPUT OR PARAMETER	PERMISSIBLE TOLERANCES %	EFFECT ON SIMULATED RUNOFF, %	RELATIONSHIP TO WATERSHED GEO-MORPHOLOGY	DERIVATION FROM REMOTE-SENSED DATA OR OTHER	REQUIRED IMAGE RESOLUTION,M
EVAPORATION DATA (EPAET)	+5 -4.5	-10 +10 (SUMMER)	POTENTIAL AVERAGE ANNUAL LAKE EVAPORATION	FIELD INSTRUMENTS AND/OR CALCULA-TION FROM CLIMATE DATA	±4.5%
MEAN NUMBER OF RAINY DAYS (MNRD)	+11.5 -10	-5 +5	CLIMATOLOGICAL STATISTICS	CLIMATOLOGICAL STATISTICS	±10%
(THE REMAINING ENTRIES IN THIS CHART PERTAIN TO THE SNOWSHED MODEL ONLY.)					
PRECIPITATION (PERTURBED ONLY DURING STORMS)	+11 -11	+5 -5	ERRORS IN PRECIPITATION INPUT	FIELD INSTRUMENTS	±11% IN PRECIP. MEASURE (RANDOM)
EVAPORATION (PERTURBED ONLY DURING STORMS)	+20 -20	-5 +5	ERRORS IN EVAPORA-TION DATA	FIELD INSTRUMENTS AND/OR CALCULA-TION FROM CLIMATE DATA	±20%
TEMPERATURE (PERTURBED ONLY DURING STORMS)	+2.3 -4.0	+20 -20	ERRORS IN TEMPERATURE DATA	FIELD INSTRUMENTS OR FUTURE REMOTE RADIOMETRY	N/A
FRACTION OF INCOMING RADIATION REFLECTED BY SNOW (FIRR)	+15 -12	-20 +20	SNOW SURFACE ALBEDO; INDE-PENDENT OF GEOMOPHOLOGY	CALCULATION IN THE MODEL FROM SNOW SURFACE AGE; RADIOMETRY IN FUTURE	N/A
BASIC DEGREE DAY FACTOR FOR SNOWMELT (BDDFSM)	+3.6 -1.6	+20 -20	MATHEMATICAL CONSTRUCT; NO RELATION TO WATERSHED GEOMORPHOLOGY	SIMULATION MODEL CALIBRA-TION; NO REMOTE SENSING APPLICATION	N/A
SNOWPACK BASIC MAXI-MUM FRACTION IN LIQUID WATER (SPBFLW)	+16 -13.5	-10 +10	SNOW PHYSICS; NO RELATION TO WATERSHED GEOMORPHOLOGY	SIMULATION MODEL CALIBRA-TION; NO REMOTE SENSING APPLICATION	N/A
SNOWPACK MINIMUM TOTAL WATER CONTENT (SPTWCC)	+0 -32.5	-1 +1	SNOW PHYSICS; NO RELATION TO WATERSHED GEOMORPHOLOGY	SIMULATION MODEL CALIBRATION; SOME FUTURE REMOTE SENSING APPLICATION	N/A
ELEVATION DIFFERENCE BETWEEN BASE THEROMETER AND MEAN BASIN ELEVATION (ELDIF)	+20 -12.5	-28 +28	BASIN TOPO-GRAPHY	DIRECT MEASUREMENT IF RELATIVE ELEVA-TIONS ARE AVAIL-ABLE	30 VERTICAL
FRACTION OF SNOW INTER-CEPTED (FFSI)	+25 -25	+10 -10	TYPE AND DENSITY OF FOREST	IMAGE DATA CLASSI-FICATION AND INTERPRETATION	500
FRACTION OF SNOW INTER-CEPTED (FFSI)	+25 -21	+2 -2	TYPE AND DENSITY OF FOREST	IMAGE DATA CLASSI-FICATION AND INTERPRETATION	200
PRECIP. INDEX FOR CHANGING SNOW ALBEDO (PXCSA)	+50 -11	+2.9 -10	SNOW PHYSICS; NO RELATION TO WATERSHED GEOMORPHOLOGY	SIMULATION MODEL CALIBRATION; RADIOMETRY IN FUTURE	N/A

of nearly any basin except small, highly urbanized ones). This small value of impervious area prevented varying OFMNIS from having any effect.

Several remarks on the information contained in Table 6-3 are in order, and they appear in the following paragraphs.

The permissible tolerances shown in the second column were generally estimated from plots such as the one shown in Figure 6-1. Some judgments and compromises were necessary because of nonlinearities in many of the response curves. The same is true to a greater extent with respect to the effect on simulated runoff appearing in the second column. The image resolutions estimated in the sixth column are believed somewhat conservative, more stringent than actually may be required, pending further study. Most of them depend upon the basin size; if one is interested in observing and simulating watersheds of areas not less than 50 square kilometers, the image resolutions can be relaxed considerably. Another consideration which enters into the estimation of required image resolution is the likelihood that parameters of interest (such as the impervious fraction of basin area) may consist of scattered small areas rather than be concentrated into a single larger one, the latter condition requiring less stringent resolutions.

The comments in the fifth column on the derivation of parameters from remote sensing should generally be regarded as optimistic. Although many of the derivations indicated are feasible, considerable maturing of several image analyses and interpretation techniques will be needed to make the applications operational. The applications are presently practical for quasi-permanent features such as land use and vegetation, but optimistic with respect to inferences about soil characteristics and subsurface conditions.

In the early days of the sensitivity analysis, some problems were encountered with respect to the impervious portion of the basin area (FIMP) and water surface portion of basin area (FWTR). In all the basins used in the study these parameters were of such small value that very large percentage variations in them caused very small variations in simulation model outputs. Because they are both excellent parameters for determination from remote-sensed data, special reference simulation runs were made with each of them separately set to .10 (that is 10% of the total basin area). Sensitivity analysis runs were then made based on departures in FIMP and FWTR from these special reference values, in order to get a more meaningful assessment of their effects on simulation model operation.

In the operation of a simulation model, it is necessary to assume that the measured precipitation inputs accurately represent the actual precipitation over the basin, even though the operator is morally certain that this is not the case. In order to test the effects of errors in precipitation input, several runs were made in which the effect of changing preciptiation was achieved by assigning values other 1.0 to the recording gage precipitation multiplier (RGPMB). The unit sensitivities resulting from the simulation runs were much greater than unity. It was concluded that varying RGPMB is

equivalent to introducing biases in the preciptiation inputs throughout the year, rather than introducing random errors as would normally be expected in the rain gage network. The effect is one of accumulating errors in soil moisture throughout the water year simulated, causing the errors in simulation output to be greater in percentage than the perturbations in RGPMB. It would be interesting, in a refinement of the study, to test the effect of introducing errors in the precipitation inputs in accordance with some probability density function. A very small step in this direction was taken in the sensitivity analysis involving the Alamosa Creek basin, for which precipitation input was perturbed only during storm events, and left at the reference value for the rest of the year. The results of this experiment appeared to be more reasonable.

6.3 DETAILED SENSITIVITY ANALYSIS RESULTS

The tabulated and plotted sensitivity analysis results are presented in the remaining pages of this section for each of 26 parameters. The set of watershed characteristics of principal interest and their reference values are presented in Table 6-4. Each set of tables and curves related to a parameter is preceded by a brief discussion of the definition of the parameter, how it is normally derived, and its effect on simulation model performance.

6.3.1 FIMP, IMPERVIOUS FRACTION OF WATERSHED AREA

FIMP is the fraction of total watershed surface which is impervious and contributes its runoff directly into channel flow. For most rural and mountain watersheds this factor will be near zero unless there are large areas of rock outcrops adjacent to stream channels. Runoff from scattered impervious areas usually flows onto a pervious area as overland flow; such areas should not be included as a portion of FIMP. Precipitation minus interception is multiplied by the impervious area fraction to determine the impervious area contribution to streamflow.

The impervious area is directly obtainable from remote sensing by land-use classification after the watershed boundary has been established.

Sensitivity analysis results (Tables 6-5 through 6-13) indicate that the FIMP parameter is most influential during fall and summer when soil is relatively dry. FIMP is most influential in light rains with dry soil conditions, and least influential during winter season.

The unit sensitivity on the average is 0.74 for fall and summer seasons, and 0.10 for winter and spring seasons. This average is based on six head water basins and the regional watershed.

Plotted Δ% runoff of fall storms (Figure 6-2) indicate a variation in -14% of FIMP results in -10% of runoff which corresponds to a unit sensitivity of 0.71 for fall season. Figures 6-3 through 6-6 show results for four watersheds.

Table 6-4. Principal Watershed Characteristics

Watershed				Soil Moisture Parameters							Channel Routing and Ground Water Parameters				Overland Flow Parameters				
NO. NAME	AREA	FIMP	FWTR	BMIR	LZC	ETLF	SUZC	SIAC	BUZC	BIVF	CXRX	FSRX	BFRC	BFNLR	OFSL	OFSS	OFMN	IFRC	OFMNIS
PEARL RIVER, MISS. SWS 1	898	.004	.005	10.0	6.0	.20	.40	.60	.60	.60	.96	.96	.96	.80	4974	.019	.056	.30	.015
SWS 2	449	.076	.002	10.0	6.0	.20	.40	.60	.60	.60	.96	.96	.96	.80	5238	.021	.081	.30	.015
SWS 3	314	.022	.001	10.0	6.0	.20	.40	.60	.60	.80	.94	.94	.96	.80	3415	.028	.070	.30	.015
SWS 4	170	.007	.001	8.0	5.0	.20	.40	.60	.60	.80	.94	.94	.96	.80	4505	.018	.048	.30	.015
SWS 5	411	.033	.002	10.0	6.0	.20	.40	.60	.60	.80	.96	.96	.96	.80	4692	.020	.068	.30	.015
SWS 6	858	.025	.070	10.0	6.0	.20	.40	.60	.60	.80	.96	.96	.96	.80	7754	.012	.076	.30	.015
SWS 7	429	.002	.001	12.0	7.0	.20	.40	.60	.60	.80	.96	.96	.96	.80	6915	.015	.065	.30	.015
SWS 8	1511	.001	.005	8.0	5.0	.20	.40	.60	.60	.80	.96	.96	.96	.80	6914	.017	.066	.30	.015
SWS 9	650	.031	.003	8.0	5.0	.20	.30	.60	.60	.80	.96	.96	.98	.80	6558	.024	.063	.40	.015
SWS 10	940	.069	.002	10.0	6.0	.20	.30	.60	.60	.80	.96	.96	.96	.85	19166	.011	.063	.40	.015
SWS 11	985	.069	.002	8.0	6.0	.20	.40	.40	.60	.60	.96	.96	.96	.80	5921	.0212	.073	.30	.015
SWS 12	975	.069	.080	12.0	7.0	.20	.40	.60	.60	.60	.96	.96	.96	.80	6914	.017	.066	.416	.015
TOWN CREEK, ALA.	141	.002	.001	7.0	4.0	.20	.20	.25	.20	.50	.94	.94	.93	.85	1550	.062	.05	.184	.014
ALAMOSA CREEK, COLO.	107	.01	.006	20.0	6.0	.30	1.5	.42	1.0	2.9	.91	.94	.95	.90	1000	.34	.35	.60	.025

TABLE 6-5

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)
SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
S000	0.002	−100	Δ% OF R/O	−60.9	−4.2	−4.4	−39.5	+3.95	−7.15
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6	STORM U/S
			REF. R/O (IN)	0.46	2.41	2.03	0.43	SIM = 7.9	F + 0.609
			PERT. R/O (IN)	0.18	2.31	1.94	0.26		W + 0.042
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SP + 0.044 SU + 0.395
D010	0.05	−50	Δ% OF R/O	−32.6	−2.1	−2.5	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6	STORM U/S
			REF. R/O (IN)	0.46	2.41	2.03	0.43	SIM = —	F + 0.652
			PERT. R/O (IN)	0.31	2.36	1.98	———		W + 0.042
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SP + 0.050 SU ———
S012	0.20	+100	Δ% OF R/O	+63.0	+4.6	+4.9	+41.9	−1.06	+ 7.31
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6	STORM U/S
			REF. R/O (IN)	0.46	2.41	2.03	0.43	SIM = 7.2	F + 0.630
			PERT. R/O (IN)	0.75	2.52	2.13	0.61		W + 0.046
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SP + 0.049 SU + 0.419
D013	0.30	+200	Δ% OF R/O	+126.1	+8.7	+9.9	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.6	STORM U/S
			REF. R/O (IN)	0.46	2.41	2.03	0.43	SIM = —	F + 0.631
			PERT. R/O (IN)	1.04	2.62	2.23	———		W + 0.044
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SP + 0.050 SU ———

TABLE 6-5A

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
01	0.0	−100	Δ% OF R/O	−63.6	−35.7	−19.1	−72.3	0.0	− 13.9
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S
			REF. R/O (IN.)	0.077	0.058	1.106	0.124		F +0.636
			PERT. R/O (IN.)	0.028	0.037	0.895	0.034		W +0.357
			REF (R/F/R/O)	38.83	—	1.61	8.79		SP +0.191 SU +0.723
02	0.05	−50	Δ% OF R/O	−31.8	−17.9	−9.5	−36.2	0.0	− 7.0
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S
			REF. R/O (IN.)	0.077	0.058	1.106	0.124		F + 0.636
			PERT. R/O (IN.)	0.052	0.048	1.0	0.079		W + 0.358
			REF (R/F/R/O)	38.83	—	1.61	8.79		SP + 0.190 SU + 0.724
04	0.15	+50	Δ% OF R/O	+31.9	+18.3	+9.4	+36.2	+3.3	+ 7.0
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S
			REF. R/O (IN.)	0.077	0.058	1.106	0.124		F + 0.638
			PERT. R/O (IN.)	0.101	0.069	1.210	0.169		W + 0.366
			REF (R/F/R/O)	38.83	—	1.61	8.79		SP + 0.188 SU + 0.724
05	0.20	+100	Δ% OF R/O	+63.8	+36.7	+18.8	+72.7	+6.7	+ 14.1
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.2	STORM U/S
			REF. R/O (IN.)	0.077	0.058	1.106	0.124		F + 0.638
			PERT. R/O (IN.)	0.126	0.079	1.313	0.214		W + 0.367
			REF (R/F/R/O)	38.83	—	1.61	8.79		SP + 0.188 SU + 0.727

TABLE 6-6

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	SIGNIFICANT STORMS 1/21/68 WINTER	SIGNIFICANT STORMS 5/9/68 SPRING	SIGNIFICANT STORMS 8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
06	0.0	−100	Δ% OF R/O	−64.7	−4.9	−13.0	−70.0	−53.8	− 16
			Δ% OF MONTHLY R/O	OCT −44.1	JAN −5.7	APR −7.8	AUG −67.2	REF = 1340 SIM = 619	STORM U/S F +0.647 W +0.049 SP +0.130 SU +0.700
			REF. R/O (IN)	0.17	1.02	0.54	0.10		
			PERT. R/O (IN)	0.06	0.97	0.47	0.03		
			REF. MONTHLY R/O (IN)	0.247	3.785	2.743	0.479		
07	0.05	−50	Δ% OF R/O	−35.3	−2.9	−6.6	−30.0	−27.3	− 8.0
			Δ% OF MONTHLY R/O	OCT −22.3	JAN −2.8	APR −3.9	AUG −34	REF = 1340 SIM = 974	STORM U/S F +0.706 W +0.058 SP +0.112 SU +0.600
			REF. R/O (IN)	0.17	1.02	0.54	0.10		
			PERT. R/O (IN)	0.11	0.99	0.51	0.07		
			REF. MONTHLY R/O (IN)	0.247	3.785	2.743	0.479		
09	0.20	+100	Δ% OF R/O	64.7	5.9	11.1	80.0	+55.5	+16.0
			Δ% OF MONTHLY R/O	OCT +44.1	JAN +5.6	APR +7.8	AUG +69.7	REF = 1340 SIM = 2083	STORM U/S F +0.647 W +0.059 SP +0.111 SU +0.800
			REF. R/O (IN)	0.17	1.02	0.54	0.10		
			PERT. R/O (IN)	0.28	1.08	0.60	0.18		
			REF. MONTHLY R/O (IN)						
10	0.30	+200	Δ% OF R/O	+129.4	+10.8	+22.2	+150.0	+112.9	+32.2
			Δ% OF MONTHLY R/O	OCT +88.7	JAN +11.3	APR +15.6	AUG +140.5	REF = 1340 SIM = 2853	STORM U/S F +0.647 W +0.540 SP +0.111 SU +0.750
			REF. R/O (IN)	0.17	1.02	0.54	0.10		
			PERT. R/O (IN)	0.39	1.13	0.66	0.25		
			REF. MONTHLY R/O (IN)						

TABLE 6-7

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
			Δ% OF R/O	–83.3	–8.0	–20.4	–79.2	+3.0	– 15.0
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
06	0.0	–100	REF. R/O (IN.)	0.24	1.74	0.93	0.24	REF = 33	F + 0.833
			PERT. R/O (IN.)	0.04	1.60	0.74	0.05	SIM = 34	W + 0.080
			REF (R/F/R/O)	9.0	1.10	3.75	11.8		SP+ 0.204 SU + 0.792
			Δ% OF R/O	–41.7	–4.0	–9.7	–37.5	0.0	– 7.5
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
07	0.05	–50	REF. R/O (IN.)	0.24	1.74	0.93	0.24	REF = 33	F +0.834
			PERT. R/O (IN.)	0.14	1.67	0.84	0.15	SIM = 33	W +0.080
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SP +0.194 SU +0.750
			Δ% OF R/O	+83.3	+7.5	+20.4	+79.2	0.0	+ 15.0
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
09	0.20	+100	REF. R/O (IN.)	0.24	1.74	0.93	0.24	REF = 33	F +0.833
			PERT. R/O (IN.)	0.44	1.87	1.12	0.43	SIM = 33	W +0.075
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SP +0.204 SU +0.792
			Δ% OF R/O	+166.7	+14.9	+40.9	+162.5	+9.1	+ 30.1
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
10	0.30	+200	REF. R/O (IN.)	0.24	1.74	0.93	0.24	REF = 33	F +0.834
			PERT. R/O (IN.)	0.64	2.00	1.31	0.63	SIM = 36	W +0.750
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SP +0.205 SU +0.813

TABLE 6-8

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
06	0.0	−100	Δ% OF R/O	−85.7	−4.4	−18.0	−75.9	+4.6	− 12.5
			STORM R/F	2.51	3.11	1.70	2.21	REF = 22 SIM = 23	STORM U/S F +0.857 W +0.044 SP +0.180 SU +0.759
			REF. R/O (IN.)	0.28	2.25	0.61	0.29		
			PERT. R/O (IN.)	0.04	2.15	0.50	0.07		
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		
07	0.05	−50	Δ% OF R/O	−42.9	−2.2	−9.8	−37.9	+4.6	− 6.2
			STORM R/F	2.51	3.11	1.70	2.21	REF = 22 SIM = 23	STORM U/S F +0.858 W +0.044 SP +0.196 WU +0.758
			REF. R/O (IN.)	0.28	2.25	0.61	0.29		
			PERT. R/O (IN.)	0.16	2.20	0.55	0.18		
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		
09	0.20	+100	Δ% OF R/O	+82.1	+4.44	+19.7	+75.9	−9.1	+12.5
			STORM R/F	2.51	3.11	1.70	2.21	REF = 22 SIM = 20	STORM U/S F +0.821 W +0.044 SP +0.197 SU +0.759
			REF. R/O (IN.)	0.28	2.25	0.61	0.29		
			PERT. R/O (IN.)	0.51	2.35	0.73	0.51		
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		
10	0.30	+200	Δ% OF R/O	167.9	+8.9	+37.7	+155.2	−13.7	+25.0
			STORM R/F	2.51	3.11	1.70	2.21	REF = 22 SIM = 19	STORM U/S F +0.840 W +0.045 SP +0.189 SU +0.776
			REF. R/O (IN.)	0.28	2.25	0.61	0.29		
			PERT. R/O (IN.)	0.75	2.45	0.84	0.74		
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		

TABLE 6-9

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
06	0.0	−100	Δ% OF R/O	−90.0	−2.6	−12.0	−90.5	+25	− 9.9
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.10	1.94	1.00	0.21	REF = 4 SIM = 5	F +0.900
			PERT. R/O (IN.)	0.01	1.89	0.88	0.02		W +0.026 SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.905
07	0.05	−50	Δ% OF R/O	−50.0	−1.0	−6.0	−42.9	0.0	−5.0
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.10	1.94	1.00	0.21	REF = 4 SIM = 4	F +1.000
			PERT. R/O (IN.)	0.05	1.92	0.94	0.12		W +0.020 SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.858
09	0.20	+100	Δ% OF R/O	+80.0	+2.6	+12.0	+90.5	0.0	+ 9.9
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.10	1.94	1.00	0.21	REF = 4 SIM = 4	F +0.800
			PERT. R/O (IN.)	0.18	1.99	1.12	0.40		W +0.026 SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.905
10	0.30	+200	Δ% OF R/O	+170.0	+5.2	+24.0	+181.0	−25.0	+ 19.9
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.10	1.94	1.00	0.21	REF = 4 SIM = 3	F +0.850
			PERT. R/O (IN.)	0.27	2.04	1.24	0.69		W +0.026 SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.905

TABLE 6-10

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
06	0.0	−100	Δ% OF R/O	−82.4	−8.8	−16.4	−72.7	+2.6	−13.8
			STORM R/F	1.58	2.76	1.92	2.95	REF = 39 SIM = 40	STORM U/S F +0.824 W +0.088 SP +0.164 SU +0.727
			REF. R/O (IN.)	0.17	1.70	0.73	0.44		
			PERT. R/O (IN.)	0.03	1.55	0.61	0.12		
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		
07	0.05	−50	Δ% OF R/O	−41.2	−4.7	−8.2	−36.4	+2.6	−6.9
			STORM R/F	1.58	2.76	1.92	2.95	REF = 39 SIM = 40	STORM U/S F +0.824 W +0.094 SP +0.164 SU +0.366
			REF. R/O (IN.)	0.17	1.70	0.73	0.44		
			PERT. R/O (IN.)	0.10	1.62	0.67	0.28		
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		
09	0.20	+100	Δ% OF R/O	+82.4	+8.2	+17.8	+72.7	+5.1	+13.8
			STORM R/F	1.58	2.76	1.92	2.95	REF = 39 SIM = 41	STORM U/S F +0.824 W +0.082 SP +0.178 SU +0.727
			REF. R/O (IN.)	0.17	1.70	0.73	0.44		
			PERT. R/O (IN.)	0.31	1.84	0.86	0.76		
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		
10	0.30	+200	Δ% OF R/O	+184.7	+16.5	+35.6	+147.7	0.0	+27.8
			STORM R/F	1.58	2.76	1.92	2.95	REF = 39 SIM = 39	STORM U/S F +0.824 W +0.082 SP +0.178 SU +0.738
			REF. R/O (IN.)	0.17	1.70	0.73	0.44		
			PERT. R/O (IN.)	0.45	1.98	0.99	1.09		
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		

TABLE 6-11

SENSITIVITY ANALYSIS OF FIMP (0.10 REF.)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS				9/14/68 LOW FLOW	ANNUAL FLOW
				10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER		
06	0.0	−100	Δ% OF R/O	−61.1	−8.9	−20.6	−75.0	0.0	−17.1
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.18	0.79	0.63	0.04	REF = 9 SIM = 9	F +0.611
			PERT. R/O (IN.)	0.07	0.72	0.50	0.01		W +0.089
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SP +0.206 SU +0.750
07	0.05	−50	Δ% OF R/O	−27.8	−3.8	−11.1	−25.0	0.0	−8.5
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.18	0.79	0.63	0.04	REF = 9 SIM = 9	F +0.556
			PERT. R/O (IN.)	0.13	0.76	0.56	0.03		W +0.076
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SP +0.222 SU +0.500
09	0.20	+100	Δ% OF R/O	+66.7	+7.6	+19.0	+75.0	0.0	+ 17.1
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.18	0.79	0.63	0.04	REF = 9 SIM = 9	F +0.667
			PERT. R/O (IN.)	0.30	0.85	0.75	0.07		W +0.076
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SP +0.190 SU +0.750
10	0.30	+200	Δ% OF R/O	+127.8	+16.5	+38.1	+175.0	0.0	+34.3
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.18	0.79	0.63	0.04	REF = 9 SIM = 9	F +0.639
			PERT. R/O (IN.)	0.41	0.92	0.87	0.11		W +0.082
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SP +0.190 SU +0.875

TABLE 6-12

SENSITIVITY ANALYSIS OF FIMP -100% PERTURBATION (0.10 REFERENCE)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S000			Δ% OF R/O	-60.9	-4.2	-4.4	-39.5	+3.95	-7.15
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.46	2.41	2.03	0.43	REF = 7.6	F +0.609 W +0.042
			PERT. R/O	0.18	2.31	1.94	0.26	SIM = 7.9	SP +0.044
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SU +0.395
RUN ID 01			Δ% OF R/O	-63.9	-35.7	-19.1	-72.3	0.0	-13.9
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.077	0.058	1.106	0.124	REF = 3.0	F +0.636 W +0.357
			PERT. R/O	0.028	0.037	0.895	0.034	SIM = 3.0	SP +0.191
			REF (R/F/R/O)	38.83	---	1.61	8.79		SU +0.723
RUN ID RW06			Δ% OF R/O	-64.7	-4.9	-13.0	-70.0	-53.8	-16.0
			Δ% OF MONTHLY R/O	OCT -44.1	JAN -5.7	APR -7.8	AUG -67.2	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.17	1.02	0.54	0.10	REF = 1340	F +0.647 W +0.049
			PERT. R/O	0.06	0.97	0.47	0.03	SIM = 619	SP +0.130
			REF. MONTHLY R/O	0.247	3.785	2.743	0.479		SU +0.700
RUN ID RW06			Δ% OF R/O	-83.3	-8.0	-20.4	-79.2	+3.0	-15.0
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.24	1.74	0.93	0.24	REF = 33	F +0.833 W +0.080
			PERT. R/O	0.04	1.60	0.74	0.05	SIM = 34	SP +0.204
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SU +0.792
RUN ID RW06			Δ% OF R/O	-85.7	-4.4	-18.0	-75.9	+4.6	-12.5
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.28	2.25	0.61	0.29	REF = 22	F +0.857 W +0.044
			PERT. R/O	0.04	2.15	0.50	0.07	SIM = 23	SP +0.180
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		SU +0.759
RUN ID RW06			Δ% OF R/O	-90.0	-2.6	-12.0	-90.5	+25	-9.9
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.10	1.94	1.00	0.21	REF = 4	F +0.900 W +0.026
			PERT. R/O	0.01	1.89	0.88	0.02	SIM = 5	SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.905
RUN ID RW06			Δ% OF R/O	-82.4	-8.8	-16.4	-72.7	+2.6	-13.8
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.17	1.70	0.73	0.44	REF = 39	F +0.824 W +0.088
			PERT. R/O	0.03	1.55	0.61	0.12	SIM = 40	SP +0.164
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		SU +0.727
RUN ID RW06			Δ% OF R/O	-61.1	-8.9	-20.6	-75.0	0.0	-17.1
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.18	0.79	0.63	0.04	REF = 9	F +0.611 W +0.089
			PERT. R/O	0.07	0.72	0.50	0.01	SIM = 9	SP +0.206
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SU +0.750

TABLE 6-13

SENSITIVITY ANALYSIS OF FIMP +100% PERTURBATION (0.10 REFERENCE)
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID S012			Δ% OF R/O	+63.0	+4.6	+4.9	+41.9	-1.06	+7.31
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.46	2.41	2.03	0.43	REF = 7.6	F +0.630 W +0.046
			PERT. R/O	0.75	2.52	2.13	0.61	SIM = 7.2	SP +0.049
			REF (R/F/R/O)	6.80	1.32	1.41	5.02		SU +0.419
RUN ID 05			Δ% OF R/O	+63.8	+36.7	+18.8	+72.7	+6.7	+14.1
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.077	0.058	1.106	0.124	REF = 3.0	F +0.638 W +0.367
			PERT. R/O	0.126	0.079	1.313	0.214	SIM = 3.2	SP +0.188
			REF (R/F/R/O)	38.83	——	1.61	8.79		SU +0.727
RUN ID RW09			Δ% OF R/O	+64.7	+5.9	+11.1	+80.0	+55.5	+16.0
			Δ% OF MONTHLY R/O	OCT	JAN	APR	AUG	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.17	1.02	0.54	0.10	REF =1340	F +0.647 W +0.059
			PERT. R/O	0.28	1.08	0.60	0.18	SIM = 2083	SP +0.111
			REF. MONTHLY R/O	0.247	3.785	2.743	0.479		SU +0.800
RUN ID RW09			Δ% OF R/O	+83.3	+7.5	+20.4	+79.2	0.0	+15.0
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.24	1.74	0.93	0.24	REF = 33	F +0.833 W +0.075
			PERT. R/O	0.44	1.87	1.12	0.43	SIM = 33	SP +0.204
			REF (R/F/R/O)	9.0	1.10	3.75	11.6		SU +0.792
RUN ID RW09			Δ% OF R/O	+82.1	+4.44	+19.7	+75.9	-9.1	+12.5
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.28	2.25	0.61	0.29	REF = 22	F +0.821 W +0.044
			PERT. R/O	0.51	2.35	0.73	0.51	SIM = 20	SP +0.197
			REF (R/F/R/O)	8.96	1.38	2.79	7.62		SU +0.759
RUN ID RW09			Δ% OF R/O	+80.0	+2.6	+12.0	+90.5	0.0	+9.9
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.10	1.94	1.00	0.21	REF = 4	F +0.800 W +0.026
			PERT. R/O	0.18	1.99	1.12	0.40(	SIM = 4	SP +0.120
			REF (R/F/R/O)	10.8	1.05	1.82	10.57		SU +0.905
RUN ID RW09			Δ% OF R/O	+82.4	+8.2	+17.8	+72.7	+5.1	+13.8
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.17	1.70	0.73	0.44	REF = 39	F +0.824 W +0.082
			PERT. R/O	0.31	1.84	0.86	0.76	SIM = 41	SP +0.178
			REF (R/F/R/O)	9.29	1.62	2.63	6.70		SU +0.727
RUN ID RW09			Δ% OF R/O	+66.7	+7.6	+19.0	+75.0	0.0	+17.1
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.18	0.79	0.63	0.04	REF = 9	F +0.667 W +0.076
			PERT. R/O	0.30	0.85	0.75	0.07	SIM = 9	SP +0.190
			REF (R/F/R/O)	7.50	1.73	3.03	12.50		SU +0.750

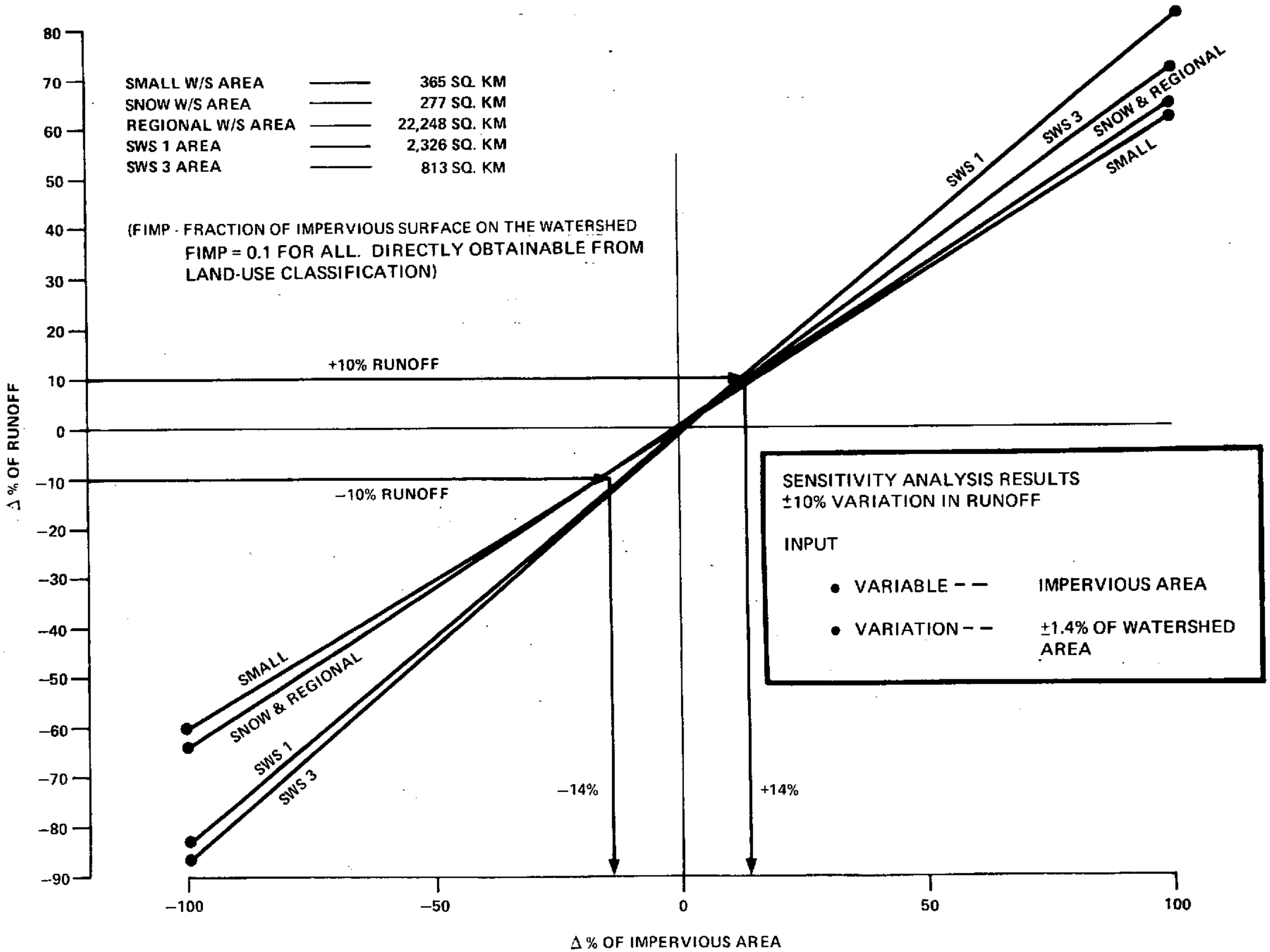


Figure 6-2. Impervious Area Study, Fall Storms

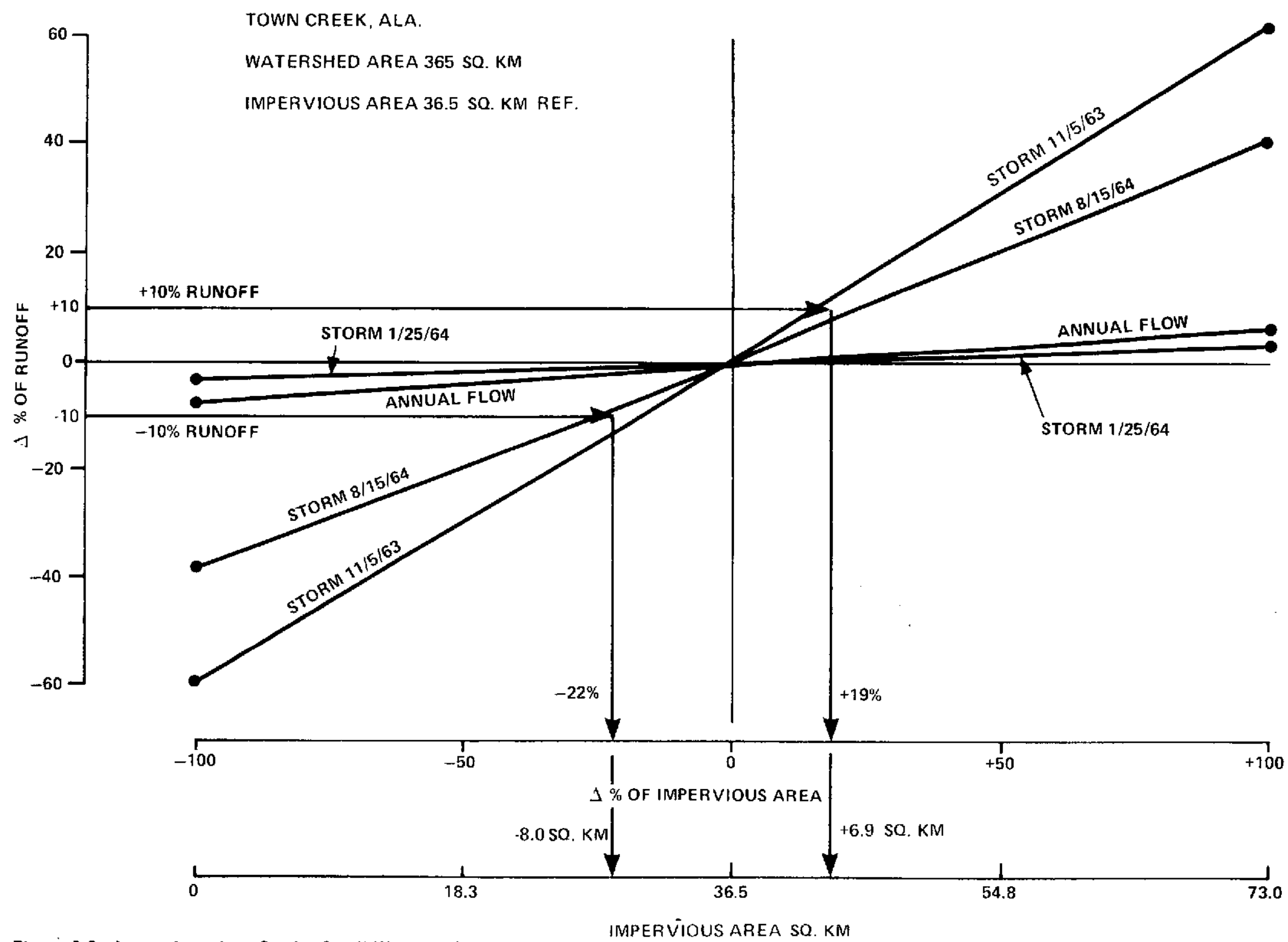


Figure 6-3. Impervious Area Study, Small Watershed

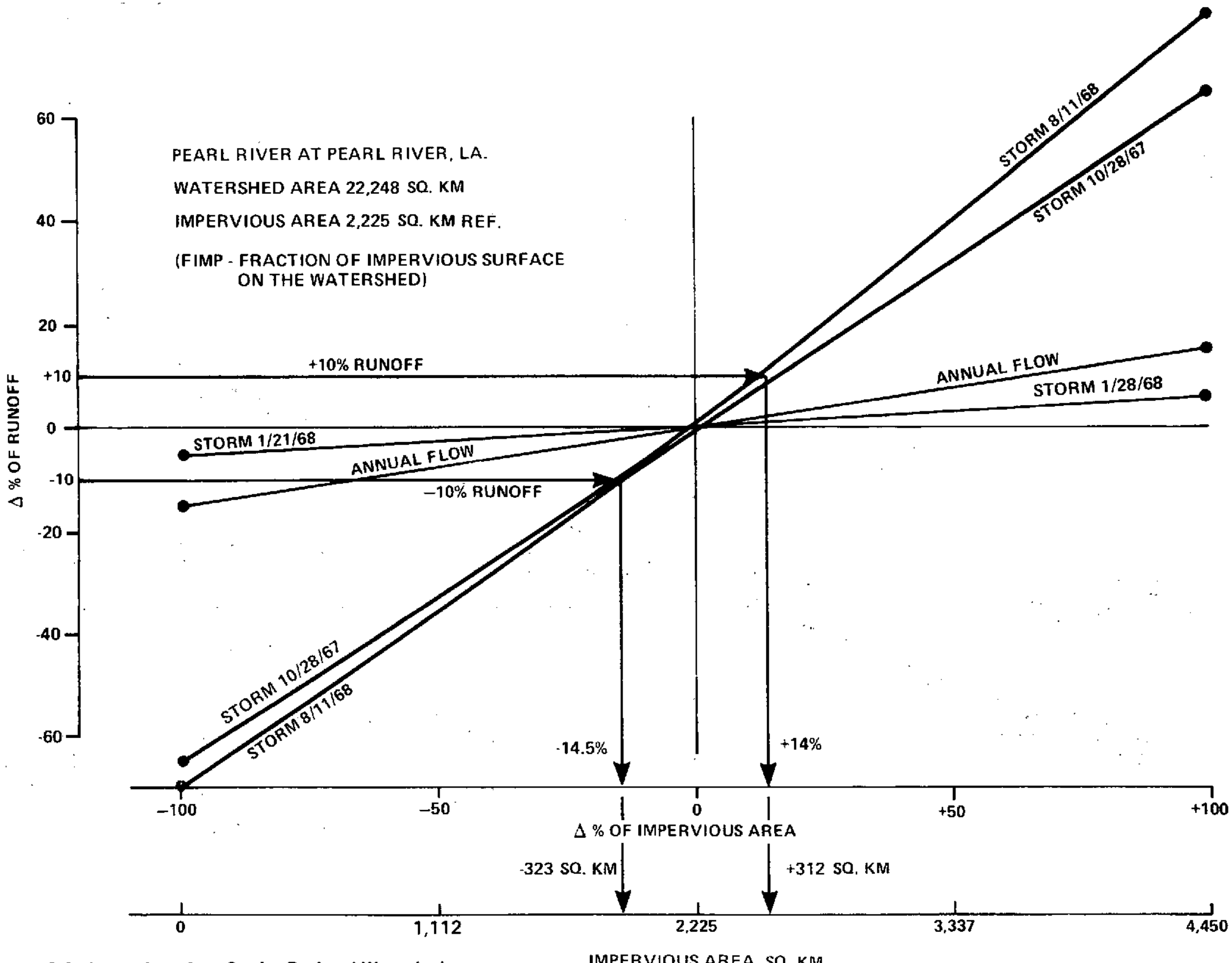


Figure 6-4. Impervious Area Study, Regional Watershed

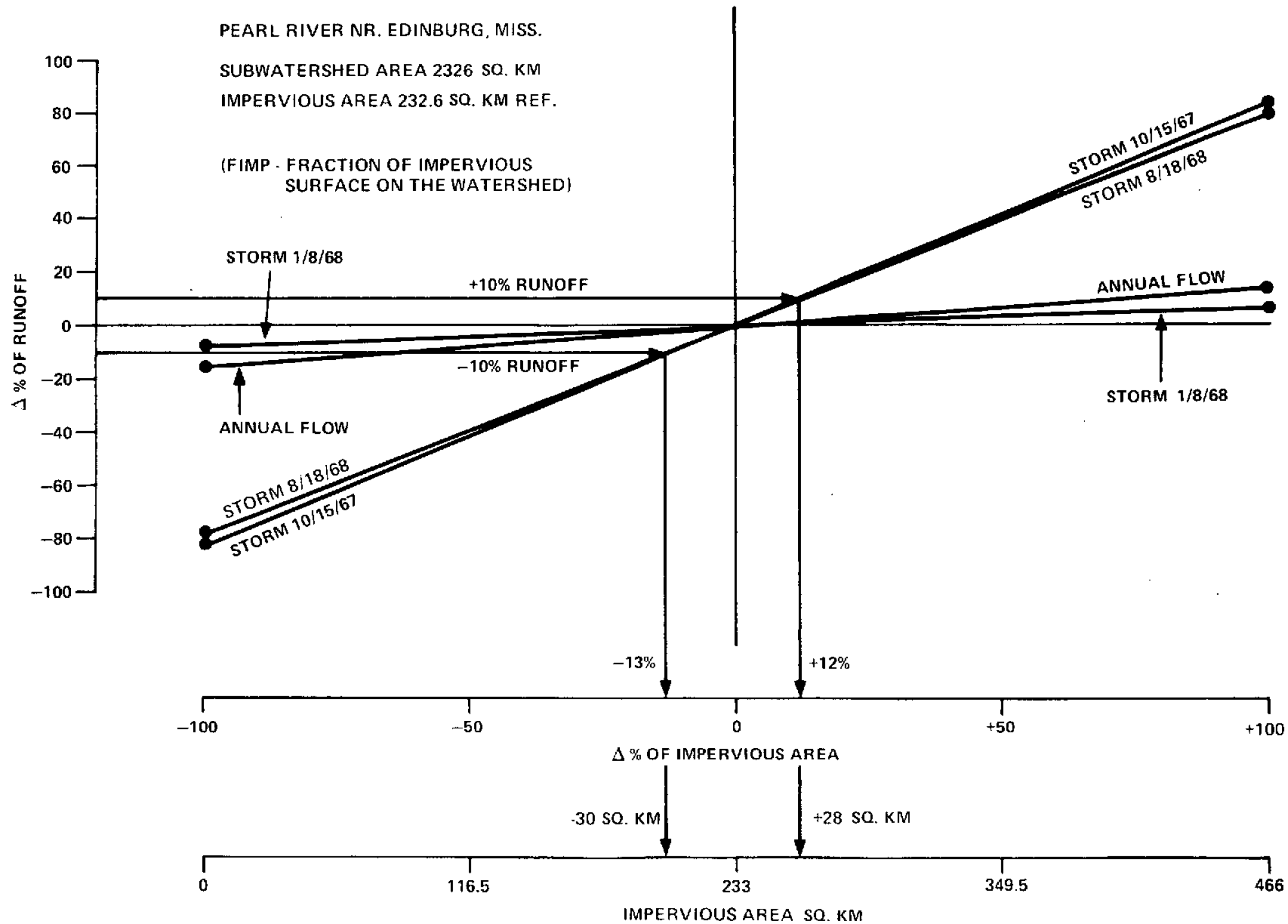


Figure 6-5. Impervious Area Study, Subwatershed No. 1

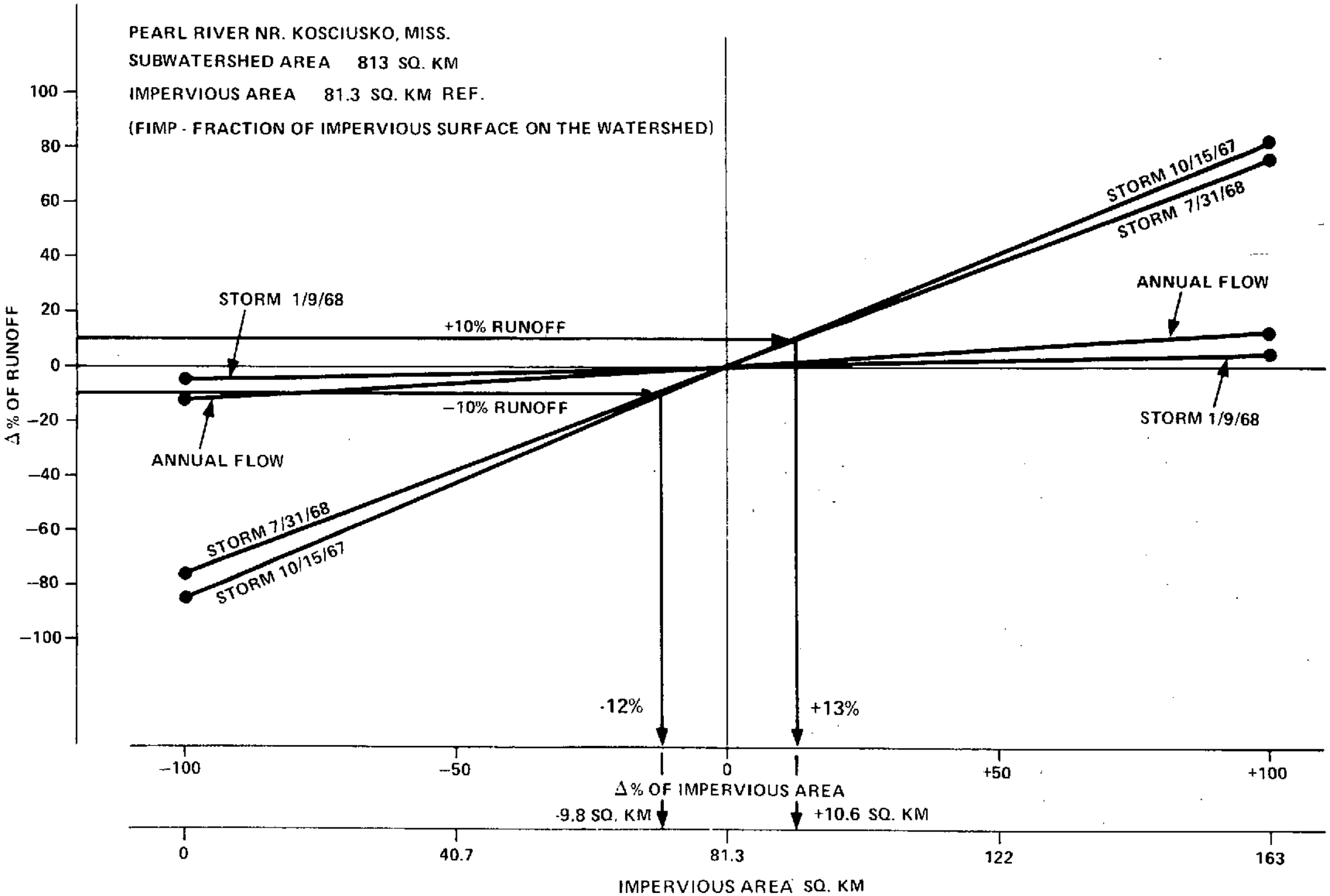


Figure 6-6. Impervious Area Study, Subwatershed No. 3

6.3.2 FWTR, WATER SURFACE FRACTION OF WATERSHED AREA

FWTR is the fraction of total watershed covered by water surfaces. This parameter refers to the proportion of water surface on the watershed including lakes, ponds, and the area of stream surface. In the simulator it is used to determine the proportion of the watershed at which evaporation occurs at potential rate. The fraction of watershed covered by water is directly obtainable from remote sensing by land-use classification after watershed boundary has been established.

Sensitivity analysis results (Tables 6-14 through 6-23) indicate that FWTR parameter is most influential during fall and summer and least influential during winter when there is little evaporation.

The unit sensitivity on the average is 0.51 for fall and summer seasons, and 0.03 for winter and spring seasons.

Plotted Δ% runoff of fall storms (Figure 6-7) indicate that variation in -16% of FWTR results in -10% of runoff which corresponds to a unit sensitivity of 0.63 for fall season. Figures 6-8 and 6-9 show results for the small and regional watersheds.

TABLE 6-14

SENSITIVITY ANALYSIS OF FWTR (0.10 REF.)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
S000	0.001	−100	Δ% OF R/O	−59.1	−3.4	0.0	−27.8	+119.4	+1.0
			STORM R/F	3.13	3.19	2.87	2.16	REF = 3.6 SIM = 7.9	STORM U/S F +0.591 W +0.034 SP +0.0 SU +0.278
			REF. R/O (IN)	0.44	2.39	1.94	0.36		
			PERT. R/O (IN)	0.18	2.31	1.94	0.26		
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		
D014	0.05	−50	Δ% OF R/O	−29.6	−1.7	0.0	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 3.6 SIM = —	STORM U/S F +0.592 W +0.034 SP +0.0 SU ———
			REF. R/O (IN)	0.44	2.39	1.94	0.36		
			PERT. R/O (IN)	0.31	2.35	1.94	———		
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		
S016	0.20	+100	Δ% OF R/O	+63.6	+3.4	+0.5	+38.9	−11.1	+2.9
			STORM R/F	3.13	3.19	2.87	2.16	REF = 3.6 SIM = 3.2	STORM U/S F +0.636 W +0.034 SP +0.500 SU +0.389
			REF. R/O (IN)	0.44	2.39	1.94	0.36		
			PERT. R/O (IN)	0.72	2.47	1.95	0.50		
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		
D017	0.30	+200	Δ% OF R/O	+129.8	+7.1	+2.1	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 3.6 SIM = —	STORM U/S F +0.648 W +0.035 SP +0.010 SU
			REF. R/O (IN)	0.44	2.39	1.94	0.36		
			PERT. R/O (IN)	1.01	2.56	1.98	———		
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		

TABLE 6-15

SENSITIVITY ANALYSIS OF FWTR (0.10 REF.)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
06	0.0	−100	Δ% OF R/O	−60.1	−4.2	−13.5	−63.3	+30.4	+3.7
			STORM R/F	2.99	0.0	1.78	1.09	REF = 2.3 SIM = 3.0	STORM U/S F +0.601 W +0.042 SP +0.135 SU +0.633
			REF. R/O (IN.)	0.075	0.041	1.050	0.113		
			PERT. R/O (IN.)	0.045	0.039	0.908	0.042		
			REF (R/F/R/O)	39.87	–––––	1.70	9.65		
07	0.05	−50	Δ% OF R/O	−30.1	−3.2	−6.8	−38.9	+8.7	−0.2
			STORM R/F	2.99	0.0	1.78	1.09	REF = 2.3 SIM = 2.5	STORM U/S F +0.602 W +0.064 SP +0.136 SU +0.778
			REF. R/O (IN.)	0.075	0.041	1.050	0.113		
			PERT. R/O (IN.)	0.053	0.040	0.979	0.069		
			REF (R/F/R/O)	39.87	—	1.70	9.65		
09	0.15	+50	Δ% OF R/O	+30.1	+15.9	+6.7	+39.0	+30.4	+2.2
			STORM R/F	2.99	0.0	1.78	1.09	REF = 2.3 SIM = 3.0	STORM U/S F +0.602 W +0.318 SP +0.134 SU +0.780
			REF. R/O (IN.)	0.075	0.041	1.050	0.113		
			PERT. R/O (IN.)	0.098	0.048	1.121	0.157		
			REF (R/F/R/O)	39.87	—	1.70	9.65		
10	0.20	+100	Δ% OF R/O	+61.3	+34.2	+13.4	+78.2	−8.7	+5.3
			STORM R/F	2.99	0.0	1.78	1.09	REF = 2.3 SIM = 2.1	STORM U/S F +0.613 W +0.342 SP +0.134 SU +0.782
			REF. R/O (IN.)	0.075	0.041	1.050	0.113		
			PERT. R/O (IN.)	0.121	0.055	1.191	0.202		
			REF (R/F/R/O)	39.87	—	1.70	9.65		

(THIS PAGE INTENTIONALY LEFT BLANK)

TABLE 6-16

SENSITIVITY ANALYSIS OF FWTR (0.10 REF.)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	–100	Δ% OF R/O	–53.3	–2.0	+8.9	–25.0	–0.1	–1.0
			Δ% OF MONTHLY R/O	OCT –15.2	JAN –2.1	APR +2.0	AUG –23.2		STORM U/S
			REF. R/O (IN)	0.15	1.00	0.45	0.08	REF = 768	F +0.533
			PERT. R/O (IN)	0.07	0.98	0.49	0.06	SIM = 767	W +0.020
			REF. MONTHLY R/O (IN)	0.191	3.703	2.560	0.340		SP –0.089 SU+0.250
RW12	0.05	–50	Δ% OF R/O	–26.7	–1.0	+4.4	–25.0	–24.5	–2.4
			Δ% OF MONTHLY R/O	OCT –14.1	JAN –1.1	APR –0.9	AUG –25.6		STORM U/S
			REF. R/O (IN)	0.15	1.00	0.45	0.08	REF = 768	F +0.534
			PERT. R/O (IN)	0.11	0.99	0.47	0.06	SIM = 580	W +0.020
			REF. MONTHLY R/O (IN)	0.191	3.703	2.560	0.340		SP –0.088 SU+0.250
RW14	0.20	+100	Δ% OF R/O	+53.3	+3.0	0.0	+50.0	+49.2	+7.4
			Δ% OF MONTHLY R/O	OCT +38.7	JAN +2.1	APR –0.8	AUG +54.1		STORM U/S
			REF. R/O (IN)	0.15	1.00	0.45	0.08	REF = 768	F +0.533
			PERT. R/O (IN)	0.23	1.03	0.45	0.12	SIM = 1146	W +0.030
			REF. MONTHLY R/O (IN)	0.191	3.703	2.560	0.340		SP 0.0 SU+0.500
RW15	0.30	+200	Δ% OF R/O	+113.3	+5.0	+4.4	+100.0	+98.3	+16.5
			Δ% OF MONTHLY R/O	OCT +80.7	JAN +4.2	APR +0.8	AUG +109.4		STORM U/S
			REF. R/O (IN)	0.15	1.00	0.45	0.08	REF = 768	F +0.566
			PERT. R/O (IN)	0.32	1.05	0.47	0.16	SIM = 1523	W +0.025
			REF. MONTHLY R/O (IN)	0.191	3.703	2.560	0.340		SP +0.022 SU+0.500

Preceding page blank

TABLE 6-17

SENSITIVITY ANALYSIS OF FWTR (0.10 REF)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM. VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	−77.8	−5.3	−6.3	−57.1	+118.5	+0.1
			STORM R/F	2.16	1.91	3.49	2.79	REF = 27 SIM = 59	STORM U/S F +0.778 W +0.053 SP +0.063 SU +0.571
			REF. R/O (IN.)	0.18	1.69	0.80	0.14		
			PERT. R/O (IN.)	0.04	1.60	0.75	0.06		
			REF (R/F/R/O)	12.00	1.13	4.36	19.93		
RW12	0.05	−50	Δ% OF R/O	−38.9	−2.4	−3.8	−35.7	+3.7	−2.0
			STORM R/F	2.16	1.91	3.49	2.79	REF = 27 SIM = 28	STORM U/S F +0.778 W +0.048 SP +0.076 SU +0.714
			REF. R/O (IN.)	0.18	1.69	0.80	0.14		
			PERT. R/O (IN.)	0.11	1.65	0.77	0.09		
			REF (R/F/R/O)	12.00	1.13 1	4.36	19.93		
RW14	0.20	+100	Δ% OF R/O	+83.3	+5.3	+7.5	+78.6	−11.1	+6.2
			STORM R/F	2.16	1.91	3.49	2.79	REF = 27 SIM = 24	STORM U/S F +0.833 W +0.053 SP +0.075 SU +0.786
			REF. R/O (IN.)	0.18	1.69	0.80	0.14		
			PERT. R/O (IN.)	0.33	1.78	0.86	0.25		
			REF (R/F/R/O)	12.00	1.13	4.36	19.93		
RW15	0.30	+200	Δ% OF R/O	+172.2	+10.7	+16.3	+157.1	−22.2	+14.2
			STORM R/F	2.16	1.91	3.49	2.79	REF = 27 SIM = 21	STORM U/S F +0.861 W +0.053 SP +0.081 SU +0.785
			REF. R/O (IN.)	0.18	1.69	0.80	0.14		
			PERT. R/O (IN.)	0.49	1.87	0.93	0.36		
			REF (R/F/R/O)	12.00	1.13	4.36	19.93		

TABLE 6-18

SENSITIVITY ANALYSIS OF FWTR (0.10 REF)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	−67.9	−2.7	+2.0	−47.8	+116.7	−0.7
			STORM R/F	2.51	3.11	1.70	2.21	REF = 12 SIM = 26	STORM U/S F +0.679 W +0.027 SP −0.020 SU +0.478
			REF. R/O (IN.)	0.28	2.23	0.51	0.23		
			PERT. R/O (IN.)	0.09	2.17	0.52	0.12		
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		
RW12	0.05	−50	Δ% OF R/O	−35.7	−1.3	+2.0	−30.4	0.0	−1.8
			STORM R/F	2.51	3.11	1.70	2.21	REF = 12 SIM = 12	STORM U/S F +0.714 W +0.026 SP −0.040 WU +0.608
			REF. R/O (IN.)	0.28	2.23	0.51	0.23		
			PERT. R/O (IN.)	0.18	2.20	0.51	0.16		
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		
RW14	0.20	+100	Δ% OF R/O	+75.0	+2.7	+9.8	+60.9	−16.7	+6.4
			STORM R/F	2.51	3.11	1.70	2.21	REF = 12 SIM = 10	STORM U/S F +0.750 W +0.027 SP +0.098 SU +0.609
			REF. R/O (IN.)	0.28	2.23	0.51	0.23		
			PERT. R/O (IN.)	0.49	2.29	0.56	0.37		
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		
RW15	0.30	+200	Δ% OF R/O	+134.4	+5.8	+17.7	+121.7	−25.0	+14.1
			STORM R/F	2.51	3.11	1.70	2.21	REF = 12 SIM = 9	STORM U/S F +0.732 W +0.029 SP +0.088 SU +0.608
			REF. R/O (IN.)	0.28	2.23	0.51	0.23		
			PERT. R/O (IN.)	0.69	2.36	0.60	0.51		
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		

TABLE 6-19

SENSITIVITY ANALYSIS OF FWTR (0.10 REF)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	−55.6	−0.5	−21	−52.6	+166.7	+0.2
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.09	1.92	0.94	0.19	REF = 3 SIM = 8	F +0.556 W +0.005
			PERT. R/O (IN.)	0.04	1.91	0.92	0.09		SP +0.021
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		SU +0.526
RW12	0.05	−50	Δ% OF R/O	−33.3	−0.5	−1.1	−31.6	+33.3	−1.0
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S F +0.666
			REF. R/O (IN.)	0.09	1.92	0.94	0.19	REF = 3 SIM = 4	W +0.010
			PERT. R/O (IN.)	0.06	1.91	0.93	0.12		SP +0.022
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		SU +0.632
RW14	0.12	+100	Δ% OF R/O	+66.7	+0.5	+1.1	+63.2	0.0	+4.2
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.09	1.92	0.94	0.19	REF = 3 SIM = 3	F +0.667 W +0.005
			PERT. R/O (IN.)	0.15	1.93	0.95	0.31		SP +0.011
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		SU +0.632
RW15	0.30	+200	Δ% OF R/O	+133.3	+1.6	+6.4	+126.3	0.0	+10.0
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.09	1.92	0.94	0.19	REF = 3 SIM = 3	F +0.666 W +0.008
			PERT. R/O (IN.)	0.21	1.95	1.00	0.43		SP +0.032
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		SU +0.631

TABLE 6-20

SENSITIVITY ANALYSIS OF FWTR (0.10 REF.)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	−78.6	−6.0	−3.2	−56.7	+121.1	−0.2
			STORM R/F	1.58	2.76	1.92	2.95	REF = 19	STORM U/S
			REF. R/O (IN.)	0.14	1.66	0.63	0.30	SIM = 42	F +0.786
			PERT. R/O (IN.)	0.03	1.56	0.61	0.13		W +0.060
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		SP +0.032
									SU +0.567
RW12	0.05	−50	Δ% OF R/O	−42.9	−3.0	−1.6	−33.3	+5.3	−2.0
			STORM R/F	1.58	2.76	1.92	2.95	REF = 19	STORM U/S
			REF. R/O (IN.)	0.14	1.66	0.63	0.30	SIM = 20	F +0.858
			PERT. R/O (IN.)	0.08	1.61	0.62	0.20		W +0.060
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		SP +0.032
									SU +0.666
RW14	0.20	+100	Δ% OF R/O	+78.6	+6.6	+6.3	+73.3	−10.5	+6.9
			STORM R/F	1.58	2.76	1.92	2.95	REF = 19	STORM U/S
			REF. R/O (IN.)	0.14	1.66	0.63	0.30	SIM = 17	F +0.786
			PERT. R/O (IN.)	0.25	1.77	0.67	0.52		W +0.066
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		SP +0.063
									SU +0.733
RW15	0.30	+200	Δ% OF R/O	+164.3	+13.3	+19.1	+143.3	−21.1	+15.8
			STORM R/F	1.58	2.76	1.92	2.95	REF = 19	STORM U/S
			REF. R/O (IN.)	0.14	1.66	0.63	0.30	SIM = 15	F +0.821
			PERT. R/O (IN.)	0.37	1.88	0.75	0.73		W +0.066
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		SP +0.095
									SU +0.716

TABLE 6-21

SENSITIVITY ANALYSIS OF FWTR (0.10 REF.)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	−31.8	−4.9	−3.3	−25.0	+125.0	+0.2
			STORM R/F	1.35	1.37	1.91	0.50	REF = 8 SIM = 18	STORM U/S F +0.318 W +0.049 SP +0.033 SU +0.250
			REF. R/O (IN.)	0.22	0.81	0.61	0.04		
			PERT. R/O (IN.)	0.15	0.77	0.59	0.03		
			REF (R/F/R/O)	6.14	1.69	3.13	12.50		
RW12	0.05	−50	Δ% OF R/O	−18.2	−2.5	−1.6	−25.0	0.0	−1.5
			STORM R/F	1.35	1.37	1.91	0.50	REF = 8 SIM = 8	STORM U/S F +0.364 W +0.050 SP +0.032 SU +0.050
			REF. R/O (IN.)	0.22	0.81	0.61	0.04		
			PERT. R/O (IN.)	0.18	0.79	0.60	0.03		
			REF (R/F/R/O)	6.14	1.69	3.13	12.50		
RW14	0.20	+100	Δ% OF R/O	+36.4	+4.9	+4.9	+25.0	−12.5	+7.0
			STORM R/F	1.35	1.37	1.91	0.50	REF = 8 SIM = 7	STORM U/S F +0.386 W +0.049 SP +0.049 SU +0.250
			REF. R/O (IN.)	0.22	0.81	0.61	0.04		
			PERT. R/O (IN.)	0.30	0.85	0.64	0.05		
			REF (R/F/R/O)	9.0	1.8		16.1		
RW15	0.30	+200	Δ% OF R/O	+77.3	+9.9	+14.8	+75.0	−25.0	+16.2
			STORM R/F	1.35	1.37	1.91	0.50	REF = 8 SIM = 6	STORM U/S F +0.386 W +0.049 SP +0.074 SU +0.375
			REF. R/O (IN.)	0.22	0.81	0.61	0.04		
			PERT. R/O (IN.)	0.39	0.89	0.70	0.07		
			REF (R/F/R/O)	6.14	1.69	3.13	12.50		

TABLE 6-22

SENSITIVITY ANALYSIS OF FWTR -100% PERTURBATION (0.10 REFERENCE)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S000			Δ% OF R/O	-59.1	-3.4	0.0	-27.8	+119.4	+1.0
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.44	2.39	1.94	0.36	REF = 3.6	F +0.591 W +0.034
			PERT. R/O	0.18	2.31	1.94	0.26	SIM = 7.9	SP +0.0
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		SU +0.278
RUN ID 06			Δ% OF R/O	-60.1	-4.2	-13.5	-63.3	+30.4	+3.7
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.075	0.041	1.050	0.113	REF = 2.3	F +0.601 W +0.042
			PERT. R/O	0.045	0.039	0.908	0.042	SIM = 3.0	SP +0.135
			REF (R/F/R/O)	39.87	--	1.70	9.65		SU +0.633
RUN ID RW11			Δ% OF R/O	-53.3	-2.0	+8.9	-25.0	-0.1	-1.0
			Δ% OF MONTHLY R/O	OCT -15.2	JAN -2.1	APR +2.0	AUG -23.2	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.15	1.00	0.45	0.08	REF = 768	F +0.533 W +0.020
			PERT. R/O	0.07	0.98	0.49	0.06	SIM = 767	SP -0.089
			REF. MONTHLY R/O	0.191	3.703	2.560	0.340		SU +0.250
RUN ID RW11			Δ% OF R/O	-77.8	-5.3	-6.3	-57.1	+118.5	+0.1
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.18	1.69	0.80	0.14	REF = 27	F +0.778 W +0.053
			PERT. R/O	0.04	1.60	0.75	0.06	SIM = 59	SP +0.063
			REF (R/F/R/O)	12.00	1.13	4.36	19.93		SU +0.571
RUN ID RW11			Δ% OF R/O	-67.9	-2.7	+2.0	-47.8	+116.7	-0.7
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.28	2.23	0.51	0.23	REF = 12	F +0.679 W +0.027
			PERT. R/O	0.09	2.17	0.52	0.12	SIM = 26	SP -0.020
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		SU +0.478
RUN ID RW11			Δ% OF R/O	-55.6	-0.5	-2.1	-52.6	+166.7	+0.2
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.09	1.92	0.94	0.19	REF = 3	F +0.556 W +0.005
			PERT. R/O	0.04	1.91	0.92	0.09	SIM = 8	SP +0.021
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		SU +0.526
RUN ID RW11			Δ% OF R/O	-78.6	-6.0	-3.2	-56.7	+121.1	-0.2
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.14	1.66	0.63	0.30	REF = 19	F +0.786 W +0.060
			PERT. R/O	0.03	1.56	0.61	0.13	SIM = 42	SP +0.032
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		SU +0.567
RUN ID RW11			Δ% OF R/O	-31.8	-4.9	-3.3	-25.0	+125.0	+0.2
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.22	0.81	0.61	0.04	REF = 8	F +0.318 W +0.049
			PERT. R/O	0.15	0.77	0.59	0.03	SIM = 18	SP +0.033
			REF (R/F/R/O)	6.14	1.69	3.13	12.50		SU +0.250

SENSITIVITY ANALYSIS OF SMALL, SNOW & REGIONAL WATERSHEDS

TABLE 6-23

FWTR · +100% PERTURBATION (0.10 REFERENCE)

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID S016			Δ% OF R/O	+63.6	+3.4	+0.5	+38.9	-11.1	+2.9
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S F +0.636 W +0.034 SP +0.500 SU +0.389
SMALL	365	45	REF. R/O	0.44	2.39	1.94	0.36	REF = 3.6	
			PERT. R/O	0.72	2.47	1.95	0.50	SIM = 3.2	
			REF (R/F/R/O)	7.11	1.33	1.48	6.00		
RUN ID 10			Δ% OF R/O	+61.3	+34.2	+13.4	+78.2	-8.7	+5.3
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S F +0.613 W +0.342 SP +0.134 SU +0.782
SNOW	277	32	REF. R/O	0.075	0.041	1.050	0.113	REF = 2.3	
			PERT. R/O	0.121	0.055	1.191	0.202	SIM = 2.1	
			REF (R/F/R/O)	39.87	—	1.70	9.65		
RUN ID RW14			Δ% OF R/O	+53.3	+3.0	0.0	+50.0	+49.2	+7.4
			Δ% OF MONTHLY R/O	OCT +38.7	JAN +2.1	APR -0.8	AUG +54.1	9/15/68	STORM U/S F +0.533 W +0.030 SP 0.0 SU +0.500
REGIONAL	22,248	41	REF. R/O	0.15	1.00	0.45	0.08	REF = 768	
			PERT. R/O	0.23	1.03	0.45	0.12	SIM = 1146	
			REF. MONTHLY R/O	0.191	3.703	2.560	0.340		
RUN ID RW14			Δ% OF R/O	+83.3	+5.3	+7.5	+78.6	-11.1	+6.2
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S F +0.833 W +0.053 SP +0.075 SU +0.786
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.18	1.69	0.80	0.14	REF = 27	
			PERT. R/O	0.33	1.78	0.86	0.25	SIM = 24	
			REF (R/F/R/O)	12.00	1.13	4.36	19.93		
RUN ID RW14			Δ% OF R/O	+75.0	+2.7	+9.8	+60.9	-16.7	+6.4
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S F +0.750 W +0.027 SP +0.098 SU +0.609
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.28	2.23	0.51	0.23	REF = 12	
			PERT. R/O	0.49	2.29	0.56	0.37	SIM = 10	
			REF (R/F/R/O)	8.96	1.39	3.33	9.61		
RUN ID RW14			Δ% OF R/O	+66.7	+0.5	+1.1	+63.2	0.0	+4.2
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S F +0.667 W +0.005 SP +0.011 SU +0.632
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.09	1.92	0.94	0.19	REF = 3	
			PERT. R/O	0.15	1.93	0.95	0.31	SIM = 3	
			REF (R/F/R/O)	12.00	1.06	1.94	11.68		
RUN ID RW14			Δ% OF R/O	+78.6	+6.6	+6.3	+73.3	-10.5	+6.9
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S F +0.786 W +0.066 SP +0.063 SU +0.733
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.14	1.66	0.63	0.30	REF = 19	
			PERT. R/O	0.25	1.77	0.67	0.52	SIM = 17	
			REF (R/F/R/O)	11.29	1.66	3.05	9.83		
RUN ID RW14			Δ% OF R/O	+36.4	+4.9	+4.9	+25.0	-12.5	+7.0
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S F +0.364 W +0.049 SP +0.049 SU +0.250
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.22	0.81	0.61	0.04	REF = 8	
			PERT. R/O	0.30	0.85	0.64	0.05	SIM = 7	
			REF (R/F/R/O)	6.14	1.69	3.13	12.50		

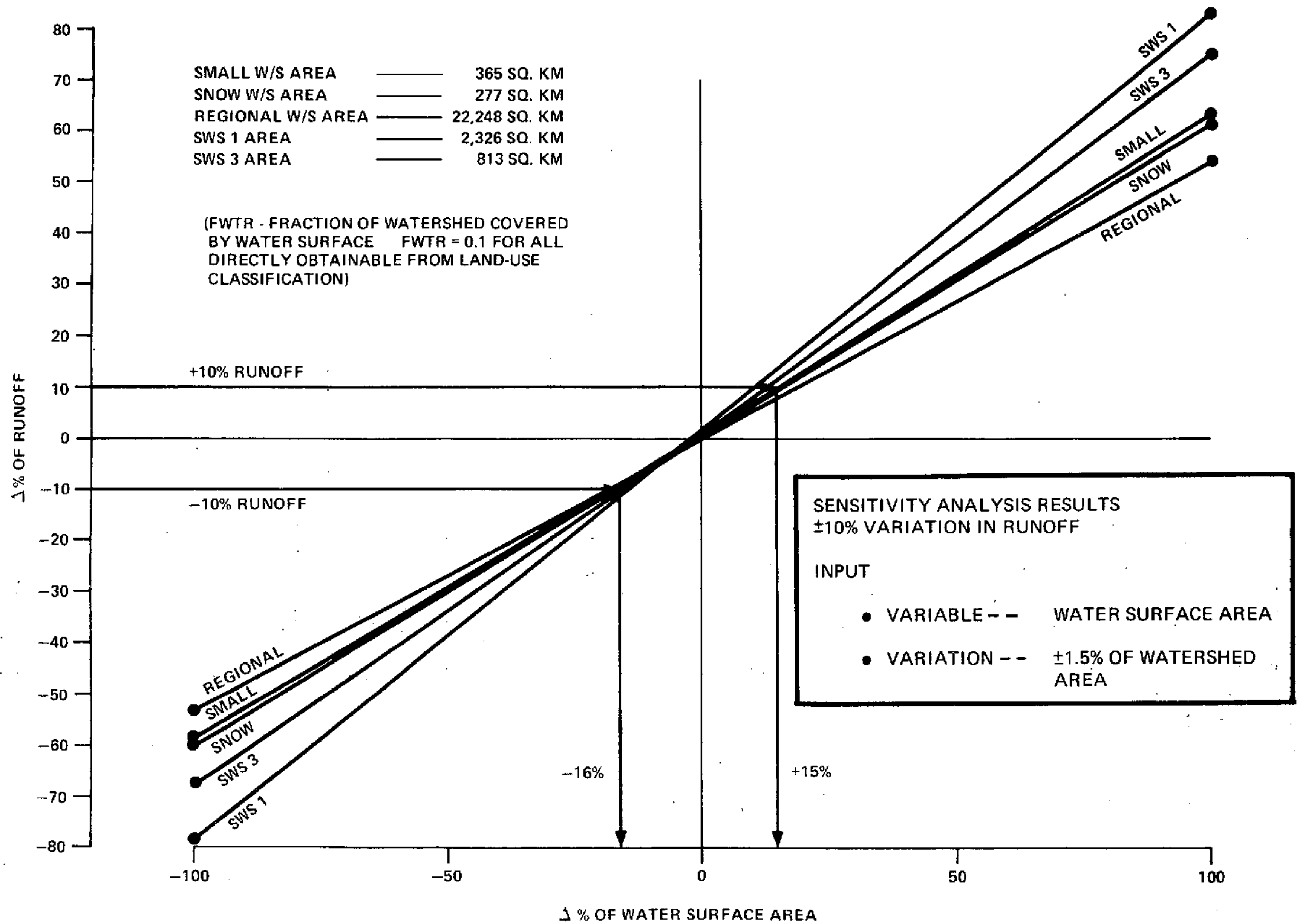


Figure 6-7. Water Surface Area Study, Fall Storms

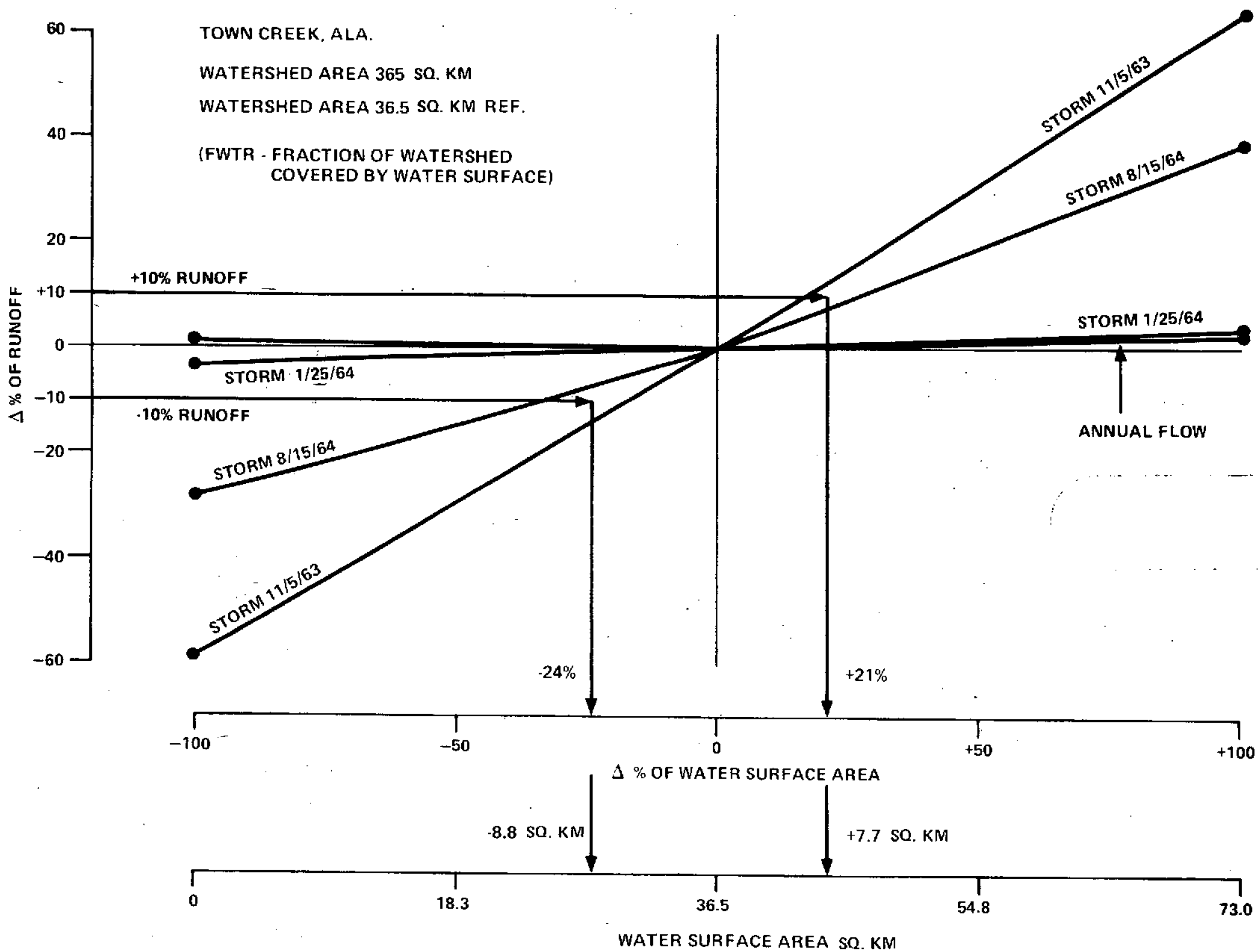


Figure 6-8. Water Surface Area Study, Small Watershed

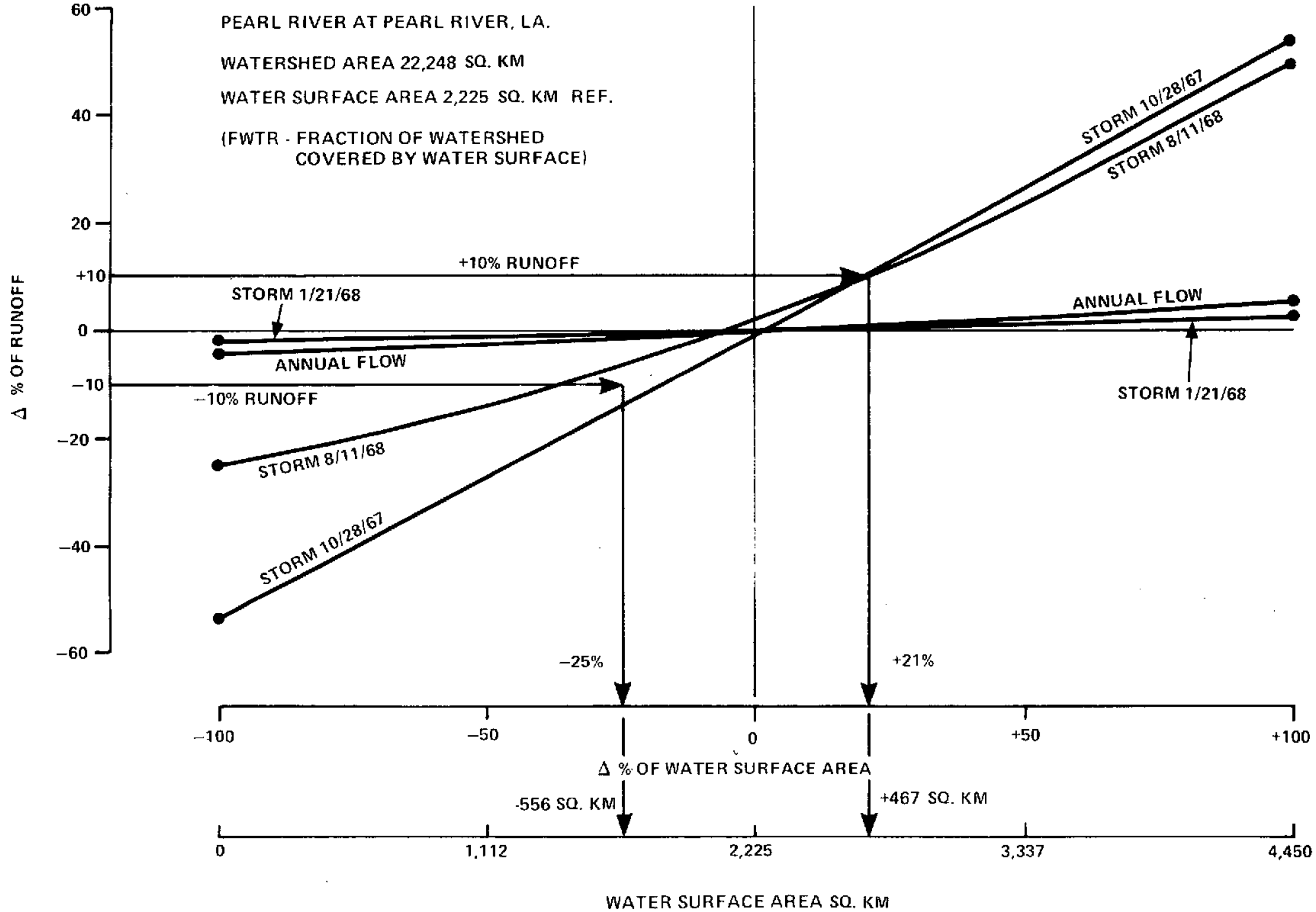


Figure 6-9. Water Surface Area Study, Regional Watershed

6.3.3 VINTMR, VEGETATIVE INTERCEPTION MAXIMUM RATE

VINTMR is the maximum volume of interception by branches and stems of vegetation. This parameter refers to the maximum volume of precipitation which will be caught and held by a vegetation canopy during a period of rainfall.

The study used the following table of values suggested by Crawford and Linsley.

WATERSHED COVER	VINTMR (INCHES)
Grassland	0.10
Moderate Forest Cover	0.15
Heavy Forest Cover	0.20

VINTMR is indirectly obtainable from remote sensing by land-use classification and the use of table such as that above.

Sensitivity analysis results (Tables 6-24 through 6-33) indicates that VINTMR is not particularly influential. In previous sensitivity analysis studies it has been shown that changing VINTMR has negligible effect during all seasons. Large changes in VINTMR showed their most pronounced effect when applied to subwatershed number 5, which experienced a light strom (total rainfall 1.08 inches) during a 7-day period and a total storm runoff of 0.04 inches. Results of this study has been plotted (Figures 6-10 through 6-14) to show that VINTMR has a unit sensitivity of 0.074 during the fall season when perturbed ±50%.

TABLE 6-24

SENSITIVITY ANALYSIS OF VINTMR J(0.15)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTUR- BATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
S018	0.001	−100	Δ% OF R/O	+0.2	−0.9	+0.8	−0.6	+5.1	+0.3
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 8.3	STORM U/S F −0.002 W +0.009 SP −0.008 SU +0.006
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.180	2.29	1.95	0.263		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S019	0.30	+100	Δ% OF R/O	−0.1	+0.7	+1.2	−0.9	−2.5	−0.04
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 7.7	STORM U/S F −0.001 W +0.007 SP +0.012 SU −0.009
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.174	2.33	1.96	0.250		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D020	0.50	+233	Δ% OF R/O	−0.2	+1.0	+3.5	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = ——	STORM U/S F −0.001 W +0.004 SP +0.015 SU ———
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.174	2.34	2.01	———		
6-42			REF (R/F/R/O)	17.9	1.38	1.47	8.3		

TABLE 6-25

SENSITIVITY ANALYSIS OF VINTMR (0.15)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
RW11	0.0	−100	Δ% OF R/O	+6.9	+17.8	−1.8	+9.5	+10.0	+3.6
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.3	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F −0.069
			PERT. R/O (IN.)	0.035	0.046	0.900	0.047		W −0.178
			REF (R/F/R/O)	91	—	1.94	25		SP +0.018 SU −0.095
RW12	0.075	−50	Δ% OF R/O	+1.1	+4.4	−0.3	+2.4	+3.3	+0.48
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F −0.022
			PERT. R/O (IN.)	0.034	0.041	0.900	0.047		W −0.088
			REF (R/F/R/O)	91	—	1.94	25		SP +0.006 SU −0.048
RW13	0.225	+50	Δ% OF R/O	−0.6	−2.6	+0.1	−2.2	0.0	−0.39
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F −0.012
			PERT. R/O (IN.)	0.032	0.038	0.917	0.042		W −0.052
			REF (R/F/R/O)	91	—	1.94	25		SP +0.002 SU −0.044
RW14	0.30	+100	Δ% OF R/O	−0.7	−4.6	+0.1	−4.5	0.0	−0.73
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F −0.007
			PERT. R/O (IN.)	−0.6	−8.7	+0.1	−8.1		W −0.046
			REF (R/F/R/O)	91	—	1.94	25		SP +0.001 SU −0.045
RW15	0.45	+200	Δ% OF R/O	−0.6	−8.7	+0.1	−8.1	0.0	−0.94
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F −0.003
			PERT. R/O (IN.)	0.032	0.036	0.917	0.040		W −0.043
			REF (R/F/R/O)	91	—	1.94	25		SP +0.005 SU −0.040

SENSITIVITY ANALYSIS OF VINTMR (0.15)

REGIONAL WATERSHED 22,248 SQ. KM

TABLE 6-26

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW16	0.0	−100	Δ% OF R/O	+9.0	+0.4	+2.9	+25.7	+32.1	+2.79
			Δ% OF MONTHLY R/O	OCT +4.52	JAN +0.19	APR +1.42	AUG +22.48		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.090
			PERT. R/O (IN)	0.11	0.981	0.50	0.08	SIM = 851	W −0.004
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SP −0.029 SU −0.257
RW138	0.075	−50	Δ% OF R/O	+1.5	+0.2	+0.6	+4.7	+3.42	+0.47
			Δ% OF MONTHLY R/O	OCT +1.13	JAN +0.06	APR +0.23	AUG +4.26		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.030
			PERT. R/O (IN)	0.10	0.982	0.490	0.067	SIM = 666	W −0.004
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SP −0.012 SU −0.094
RW139	0.225	+50	Δ% OF R/O	−1.4	−0.1	−0.3	−4.3	−1.24	−0.41
			Δ% OF MONTHLY R/O	OCT −1.13	JAN −0.06	APR −0.19	AUG −3.88		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.028
			PERT. R/O (IN)	0.097	0.979	0.486	0.061	SIM = 636	W −0.002
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SP −0.006 SU −0.086
RW17	0.30	+100	Δ% OF R/O	−2.6	−0.1	−0.7	−8.5	−2.48	−0.74
			Δ% OF MONTHLY R/O	OCT −2.26	JAN −0.03	APR −0.35	AUG −7.36		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.026
			PERT. R/O (IN)	0.099	0.98	0.48	0.06	SIM = 628	W −0.001
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SP −0.007 SU −0.085
RW18	0.50	+233	Δ% OF R/O	−5.2	0.0	−1.4	−17.9	−5.12	−1.55
			Δ% OF MONTHLY R/O	OCT −4.52	JAN −0.06	APR −2.54	AUG −16.28		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.022
			PERT. R/O (IN)	0.09	0.98	0.48	0.05	SIM = 611	W −0.0
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SP −0.006 SU −0.077

TABLE 6-27

SENSITIVITY ANALYSIS OF VINTMR (0.15)

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

SUBWATERSHED NO. 1 2,326 SQ. KM

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW16	0.0	−100	Δ% OF R/O	+3.6	−0.3	+1.8	+20.7	+26.5	+1.71
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 43	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F −0.036
			PERT. R/O (IN.)	0.05	1.60	0.76	0.07		W +0.003 SP −0.018
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −0.207
RW138	0.075	−50	Δ% OF R/O	+0.4	+0.2	+0.2	+1.2	0.0	+0.21
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 34	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F −0.008
			PERT. R/O (IN.)	0.045	1.612	0.751	0.059		W −0.004 SP −0.004
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −0.024
RW139	0.225	+50	Δ% OF R/O	−0.4	0.0	0.0	−0.8	−2.94	−0.13
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 33	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F −0.008
			PERT. R/O (IN.)	0.044	1.609	0.749	0.058		W 0.0 SP 0.0
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −0.016
RW17	0.30	+100	Δ% OF R/O	−0.8	+0.2	−0.2	−1.6	−2.94	−0.24
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 33	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F −0.008
			PERT. R/O (IN.)	0.04	1.61	0.74	0.059		W +0.002 SP −0.002
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −0.016
RW18	0.50	+233	Δ% OF R/O	−1.8	+0.3	−0.6	−3.5	−5.88	−0.49
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 32	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.747	0.059		F −0.007
			PERT. R/O (IN.)	0.04	1.61	0.74	0.06		W +0.001 SP −0.003
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −0.015

TABLE 6-28

SENSITIVITY ANALYSIS OF VINTMR (0.15)
SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW 16	0.0	−100	Δ% OF R/O	+3.5	−0.2	−2.4	+7.3	+4.35	+0.97
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 24	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F −0.035
			PERT. R/O (IN.)	0.10	2.16	0.53	0.13		W +0.002
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP +0.024 SU −0.073
RW 138	0.075	−50	Δ% OF R/O	+0.4	+0.2	+0.1	+0.8	0.0	+0.05
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F −0.008
			PERT. R/O (IN.)	0.095	2.173	0.522	0.118		W −0.004
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP −0.002 WU −0.016
RW 139	0.225	+50	Δ% OF R/O	−0.4	0.0	0.0	−0.5	0.0	−0.04
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F −0.008
			PERT. R/O (IN.)	0.094	2.169	0.521	0.116		W 0.0
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP 0.0 SU −0.010
RW 17	0.30	+100	Δ% OF R/O	−0.9	0.0	−0.2	−1.0	0.0	−0.04
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F −0.009
			PERT. R/O (IN.)	0.09	2.17	0.52	0.12		W 0.0
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP −0.002 SU −0.010
RW 18	0.50	+233	Δ% OF R/O	−2.0	−0.5	−0.6	−2.5	0.0	−0.23
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F −0.009
			PERT. R/O (IN.)	0.09	2.16	0.52	0.11		W −0.002
			REF (R/F/R/O)	26.4	1.43	3.25	18.9		SP −0.003 SU −0.011

TABLE 6-29

SENSITIVITY ANALYSIS OF VINTMR (0.15)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW 16	0.0	−100	Δ% OF R/O	+18.4	−0.3	+1.6	+14.8	+25.0	+1.02
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 5	F −0.184
			PERT. R/O (IN.)	0.04	1.90	0.94	0.10		W +0.003
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP −0.016 SU −0.148
RW 138	0.075	−50	Δ% OF R/O	+3.7	+0.2	+0.2	+2.5	+25.0	+0.10
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 5	F −0.074
			PERT. R/O (IN.)	0.037	1.912	0.924	0.088		W −0.004
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP −0.004 SU −0.050
RW 139	0.225	+50	Δ% OF R/O	−3.7	−0.1	−0.2	−2.5	0.0	−0.07
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 4	F −0.074
			PERT. R/O (IN.)	0.035	1.905	0.920	0.084		W −0.002
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP −0.004 SU −0.050
RW 17	0.30	+100	Δ% OF R/O	−7.4	−0.1	−0.3	−4.6	0.0	−0.14
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 4	F −0.074
			PERT. R/O (IN.)	0.03	1.91	0.92	0.08		W −0.001
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP −0.003 SU −0.046
RW 18	0.50	+233	Δ% OF R/O	−16.1	0.0	+0.7	−11.0	0.0	−0.35
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 4	F −0.069
			PERT. R/O (IN.)	0.03	1.91	0.92	0.08		W 0.0
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP +0.003 SU −0.050

6-47

TABLE 6-30

SENSITIVITY ANALYSIS OF VINTMR (0.16)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW 16	0.0	−100	Δ% OF R/O	+2.0	−0.4	+2.3	+4.1	+7.5	+1.29
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 43	STORM U/S F −0.020 W +0.004 SP −0.023 SU −0.041
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.56	0.62	0.13		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 138	0.075	−50	Δ% OF R/O	+0.1	−0.2	+0.6	+0.6	+2.5	+0.16
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 41	STORM U/S F −0.002 W +0.004 SP −0.012 SU −0.012
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.029	1.554	0.613	0.128		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 139	0.225	+50	Δ% OF R/O	−0.2	+0.1	−0.2	−0.4	0.0	−0.13
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 40	STORM U/S F −0.004 W +0.002 SP −0.004 SU −0.008
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.029	1.558	0.608	0.126		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 17	0.30	+100	Δ% OF R/O	−0.4	0.0	−0.4	−0.8	0.0	−0.25
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 40	STORM U/S F −0.004 W 0.0 SP −0.004 SU −0.008
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.56	0.61	0.13		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 18	0.50	+233	Δ% OF R/O	−0.9	0.0	−1.0	−1.6	−2.5	−0.55
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 39	STORM U/S F −0.004 W −0.0 SP −0.004 SU −0.007
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.56	0.60	0.12		
6-48			REF (R/F/R/O)	54.5	1.77	3.14	23.2		

TABLE 6-31

SENSITIVITY ANALYSIS OF VINTMR (0.15)

SUBWATERSHED NO. 11 2,651 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW 16	0.0	−100	Δ% OF R/O	+6.3	−1.0	+3.1	+38.8	+22.2	+2.97
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 11	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.063
			PERT. R/O (IN.)	0.16	0.76	0.61	0.04		W +0.010
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP −0.031 SU −0.388
RW 138	0.075	−50	Δ% OF R/O	+1.7	+0.13	+1.0	+9.0	+11.1	+0.70
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.034
			PERT. R/O (IN.)	0.153	0.770	0.593	0.034		W −0.003
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP −0.010 SU −0.090
RW 139	0.225	+50	Δ% OF R/O	−1.8	0.0	−1.6	−8.7	0.0	−0.60
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 9	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.018
			PERT. R/O (IN.)	0.148	0.769	0.578	0.029		W 0.0
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP −0.016 SU −0.087
RW 17	0.30	+100	Δ% OF R/O	−3.5	+0.2	−3.1	−16.4	−11.1	−1.17
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.035
			PERT. R/O (IN.)	0.14	0.77	0.57	0.03		W +0.002
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP −0.031 SU −0.164
RW 18	0.50	+233	Δ% OF R/O	−7.3	−0.4	−5.9	−29.5	−11.1	−2.32
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.031
			PERT. R/O (IN.)	0.14	0.77	0.55	0.02		W −0.025
6-49			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP −0.002 SU −0.127

TABLE 6-32

SENSITIVITY ANALYSIS OF VINTMR +50% PERTURBATION (0.15)

SMALL, SNOW & REGIONAL WATERSHEDS

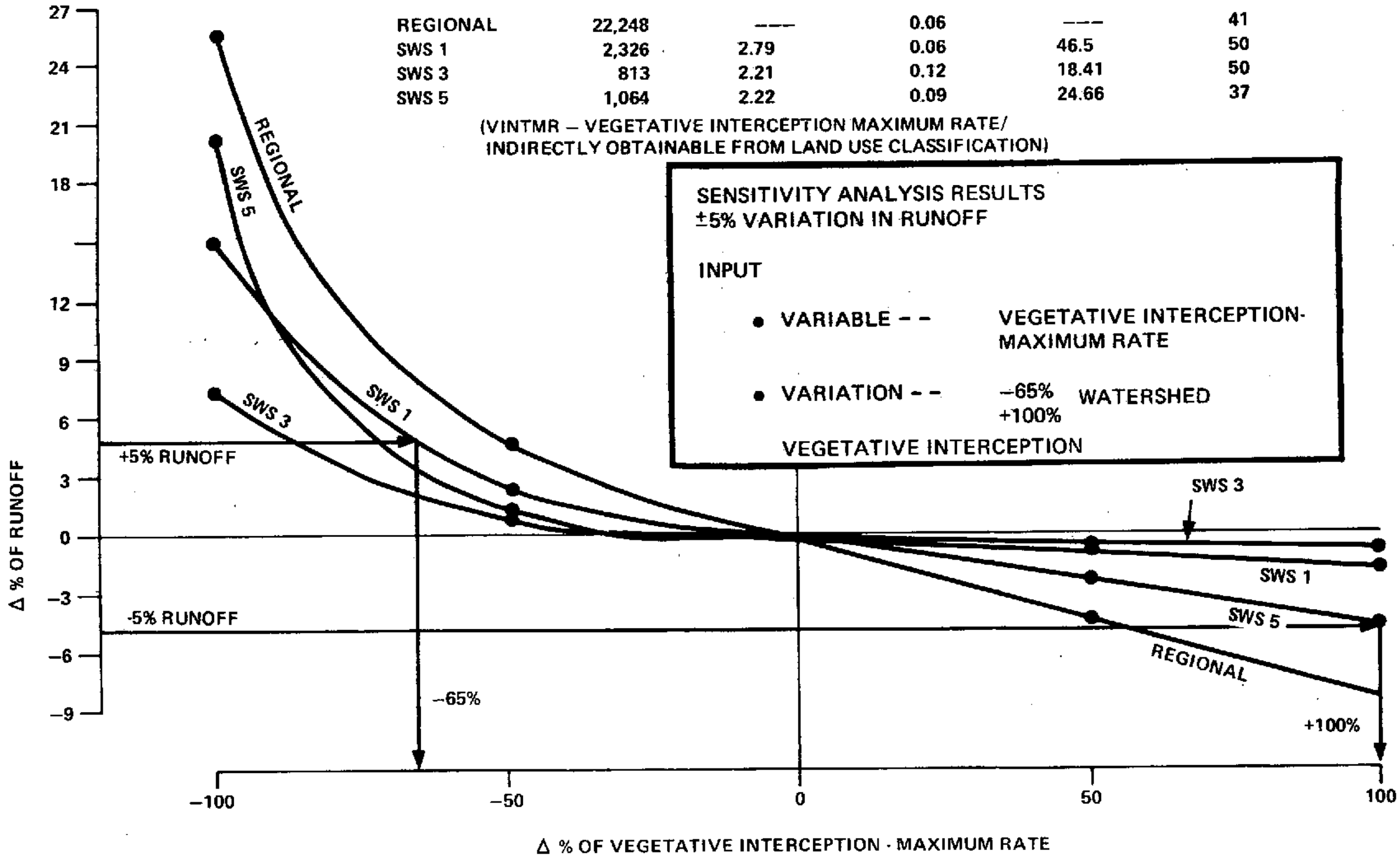
WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F
			PERT. R/O					SIM =	W SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O	-0.6	-2.6	+0.1	-2.2	0.0	-0.39
13			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.012
			PERT. R/O	0.032	0.038	0.917	0.042	SIM = 3.0	W -0.052 SP +0.002
			REF (R/F/R/O)	91	––	1.94	25		SU -0.044
RUN ID			Δ% OF R/O	-1.4	-0.1	-0.3	-4.3	-1.25	-0.41
RW139			Δ% OF MONTHLY R/O	OCT -1.13	JAN -0.06	APR -0.19	AUG -3.88	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.028
			PERT. R/O	0.097	0.979	0.486	0.061	SIM = 636	W -0.002 SP -0.006
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.086
RUN ID			Δ% OF R/O	-0.4	0.0	0.0	-0.8	-2.94	-0.13
RW139			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.008
			PERT. R/O	0.044	1.609	0.749	0.058	SIM = 33	W 0.0 SP 0.0
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.016
RUN ID			Δ% OF R/O	-0.4	0.0	0.0	-0.5	0.0	-0.04
RW139			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.008
			PERT. R/O	0.094	2.169	0.521	0.116	SIM = 23	W 0.0 SP 0.0
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.010
RUN ID			Δ% OF R/O	-3.7	-0.1	-0.2	-2.5	0.0	-0.07
RW139			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.074
			PERT. R/O	0.035	1.905	0.920	0.084	SIM = 4	W -0.002 SP -0.004
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.050
RUN ID			Δ% OF R/O	-0.2	+0.1	-0.2	-0.4	0.0	-0.13
RW139			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.004
			PERT. R/O	0.029	1.558	0.608	0.126	SIM = 40	W +0.002 SP -0.004
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.008
RUN ID			Δ% OF R/O	-1.8	0.0	-1.6	-8.7	0.0	-0.060
RW139			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.018
			PERT. R/O	0.148	0.769	0.578	0.029	SIM = 9	W 0.0 SP -0.016
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.087

TABLE 6-33

SENSITIVITY ANALYSIS OF VINTMR -50% PERTURBATION (0.15)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID 12			Δ% OF R/O	+1.1	+4.4	-0.03	+2.4	+3.3	+0.48
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.022 W -0.088
			PERT. R/O	0.34	0.041	0.913	0.044	SIM = 3.1	SP +0.006
			REF (R/F/R/O)	91	---	1.94	25		SU 0.048
RUN ID RW138			Δ% OF R/O	+1.5	+0.2	+0.6	+4.7	+3.42	+0.47
			Δ% OF MONTHLY R/O	OCT +1.13	JAN +0.06	APR +0.23	AUG +4.26	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.030 W -0.004
			PERT. R/O	0.10	0.982	0.490	0.067	SIM = 666	SP -0.012
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.094
RUN ID RW138			Δ% OF R/O	+0.4	+0.2	+0.2	+1.2	0.0	+0.21
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.008 W -0.004
			PERT. R/O	0.045	1.612	0.751	0.059	SIM = 34	SP -0.004
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.024
RUN ID RW138			Δ% OF R/O	-0.4	0.0	0.0	-0.5	0.0	-0.04
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.008 W 0.0
			PERT. R/O	0.094	2.169	0.521	0.116	SIM = 23	SP 0.0
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.010
RUN ID RW138			Δ% OF R/O	+3.7	+0.2	+0.2	+2.5	+25.0	+0.10
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.074 W -0.004
			PERT. R/O	0.037	1.912	0.924	0.088	SIM = 5	SP -0.004
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.050
RUN ID RW138			Δ% OF R/O	+0.1	-0.2	+0.6	+0.6	+2.5	+0.16
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.002 W +0.004
			PERT. R/O	0.029	1.554	0.613	0.128	SIM = 41	SP -0.012
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.012
RUN ID RW138			Δ% OF R/O	+1.7	+0.13	+1.0	+9.0	+11.1	+0.70
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.034 W -0.003
			PERT. R/O	0.153	0.770	0.593	0.034	SIM = 10	SP -0.010
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.090



	AREA SQ. KM	RAINFALL IN	RUNOFF IN	RF/RO	EPAET IN
REGIONAL	22,248	---	0.06	---	41
SWS 1	2,326	2.79	0.06	46.5	50
SWS 3	813	2.21	0.12	18.41	50
SWS 5	1,064	2.22	0.09	24.66	37

(VINTMR – VEGETATIVE INTERCEPTION MAXIMUM RATE/
INDIRECTLY OBTAINABLE FROM LAND USE CLASSIFICATION)

Figure 6-10. Vegetative Interception Study, Fall Storms

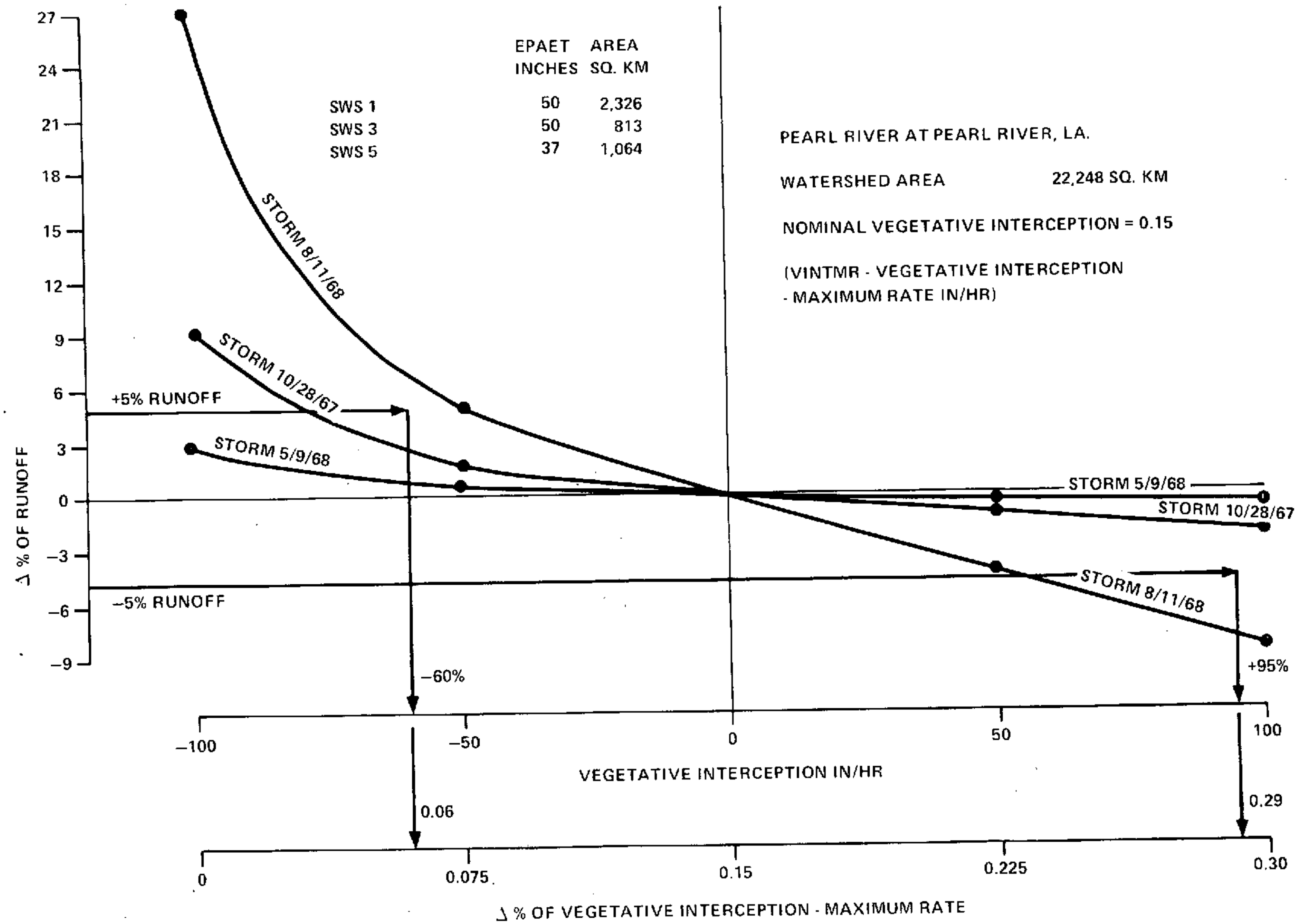


Figure 6-11. Vegetative Interception Study, Regional Watershed

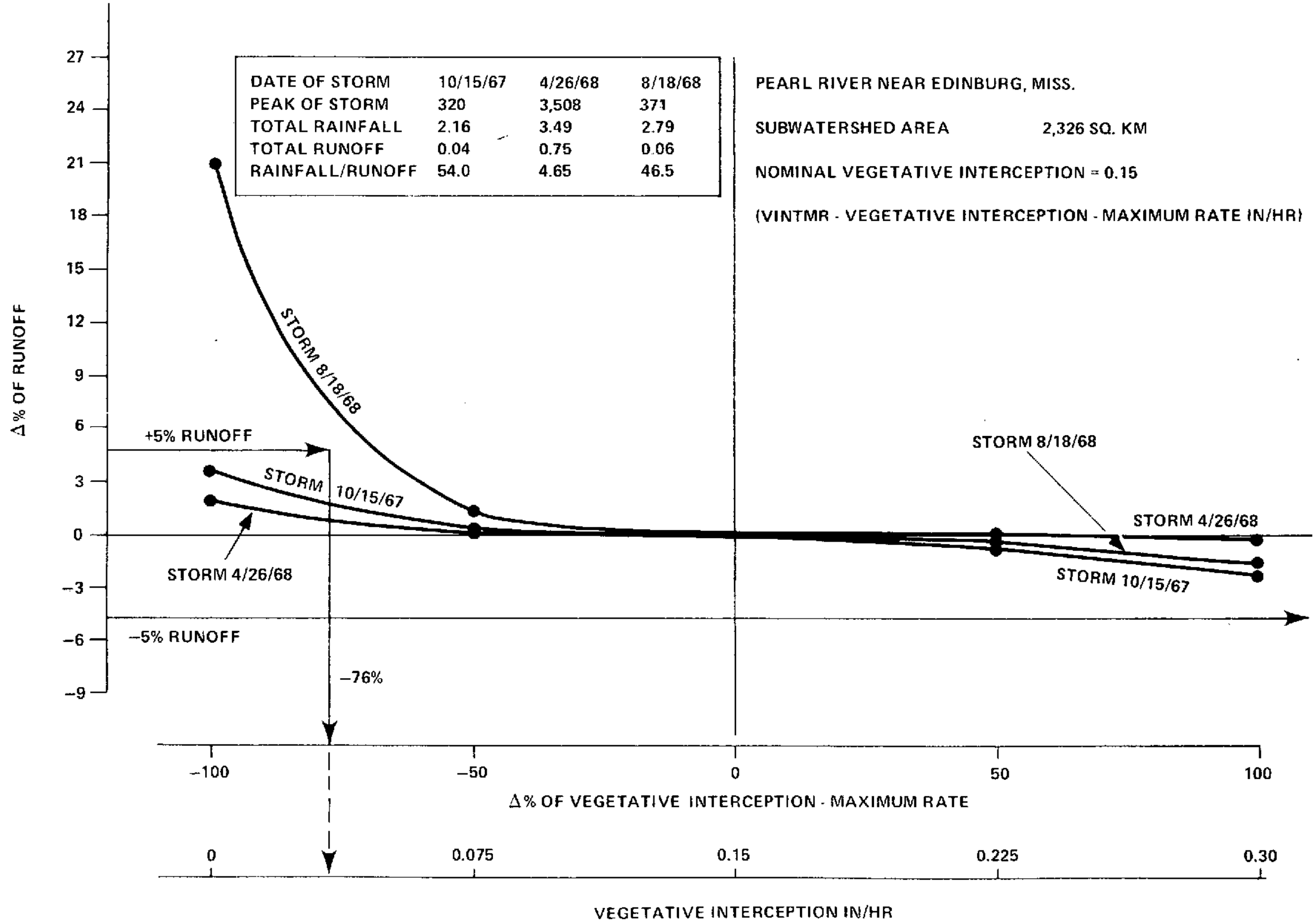


Figure 6-12. Vegetative Interception Study, Subwatershed No. 1

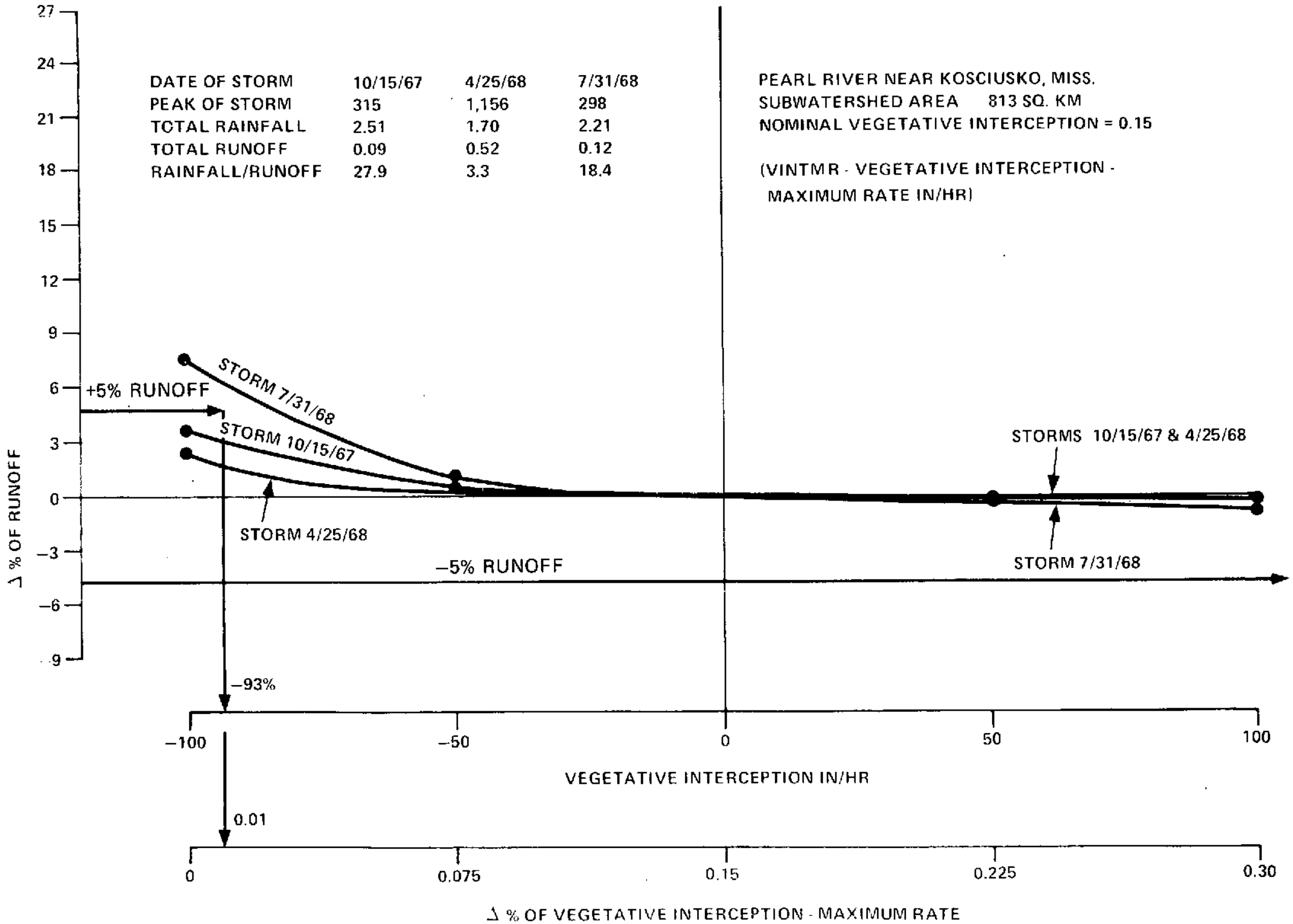


Figure 6-13. Vegetative Interception Study, Subwatershed No. 3

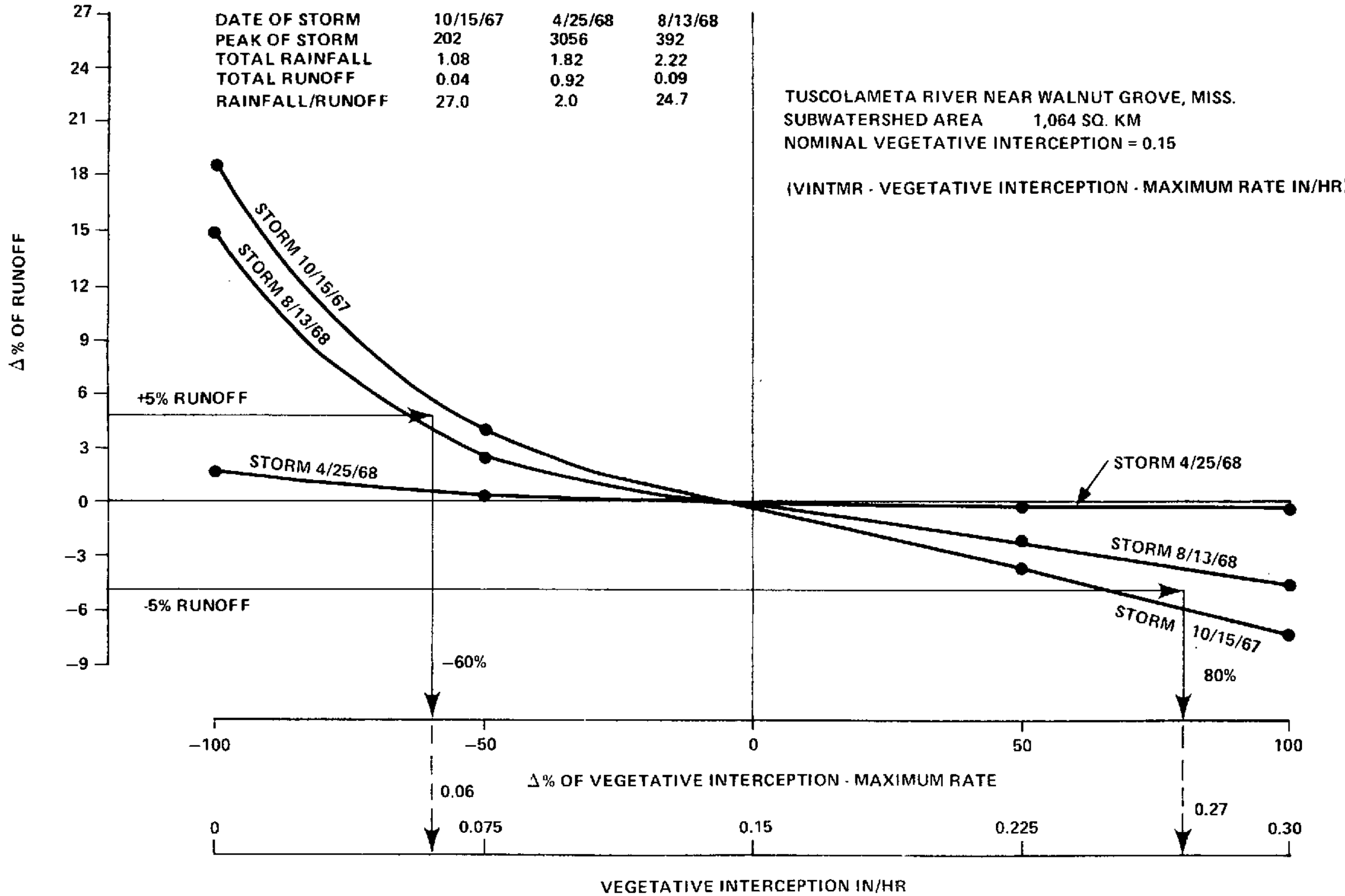


Figure 6-14. Vegetative Interception Study, Subwatershed No. 5

6.3.4 BUZC, BASIC UPPER ZONE CAPACITY

BUZC is an index for estimating the storage capacity of the soil surface (upper zone) to store water in depression storage. In the future BUZC can be inferred from land-use classification when a relationship to average slope of watershed, forest cover, and permeability of soil is established. At present, BUZC is quantified by calibration and fine tuning.

Sensitivity analysis results (Tables 6-34 through 6-44) indicates that BUZC parameter is most influential in low flows and during the fall season. The highest unit sensitivity of 0.162 was obtained in a significant fall storm for a -50% perturbation. Plots appear in Figure 6-15.

TABLE 6-34

SENSITIVITY ANALYSIS OF BUZC (0.20)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D022	0.001	-100	Δ% OF R/O	0.0	0.0	0.0	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	0.18	2.31	1.94	–	SIM = –	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU –
S023	0.10	- 50	Δ% OF R/O	0.0	0.0	0.0	+1.2	+1.27	+0.06
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	0.18	2.31	1.94	0.26	SIM = 8.0	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU -0.024
S024	0.30	+ 50	Δ% OF R/O	+0.6	0.0	0.0	-1.3	0.0	-0.08
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F -0.012
			PERT. R/O (IN)	0.18	2.31	1.94	0.25	SIM = 7.9	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU 0.026
D025	0.40	+100	Δ% OF R/O	0.0	0.0	0.0	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	–	–	–	–	SIM = –	W 0.0
6-58			REF (R/F/R/O)	17.9	3.19	1.47	8.3		SP 0.0 SU –

TABLE 6-35

SENSITIVITY ANALYSIS OF BUZC (1.0)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
118	0.0	-100	Δ% OF R/O	+12.9	+9.3	+0.6	+0.1	+13.3	+0.40
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.4	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F -0.129
			PERT. R/O (IN.)	0.037	0.043	0.922	0.043		W -0.093 SP -0.006
			REF (R/F/R/O)	91	—	1.94	25		SU -0.001
119	2.0	+100	Δ% OF R/O	-9.0	-7.2	-0.6	-0.1	-10.0	-0.39
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.7	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F -0.090
			PERT. R/O (IN.)	0.030	0.037	0.911	0.043		W -0.072 SP -0.006
			REF (R/F/R/O)	91	—	1.94	25		SU -0.001

TABLE 6-36

SENSITIVITY ANALYSIS OF BUZC (0.60)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW20	0.0	-100	Δ% OF R/O	+3.5	+0.4	+1.1	+3.5	+15.37	+0.95
			Δ% OF MONTHLY R/O	OCT +2.26	JAN +0.50	APR +0.19	AUG +4.26	REF = 644 SIM = 743	STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064		F -0.035
			PERT. R/O (IN)	0.10	0.98	0.49	0.07		W -0.004 SP -0.011
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.035
RW22	0.30	- 50	Δ% OF R/O	+1.7	+0.2	+0.6	+1.7	+7.14	+0.48
			Δ% OF MONTHLY R/O	OCT +1.13	JAN +0.22	APR +0.12	AUG +1.94	REF = 644 SIM = 690	STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064		F -0.034
			PERT. R/O (IN)	0.10	0.98	0.49	0.07		W -0.004 SP -0.012
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.034
RW21	0.90	+ 50	Δ% OF R/O	-1.5	-0.2	-0.6	-1.5	-6.60	-0.44
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -0.25	APR -0.12	AUG -1.55	REF = 644 SIM = 605	STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064		F -0.030
			PERT. R/O (IN)	0.10	0.98	0.48	0.06		W -0.004 SP -0.012
6-59			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.030

TABLE 6-37

SENSITIVITY ANALYSIS OF BUZC (0.60)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.33 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/10/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW20	0.0	-100	Δ% OF R/O	+7.4	+0.3	+0.8	+7.9	+17.65	+0.88
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.074
			PERT. R/O (IN.)	0.05	1.61	0.75	0.06	SIM = 30	W -0.003
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.008 SU -0.079
RW22	0.30	-50	Δ% OF R/O	+3.6	+0.1	+0.4	+3.8	+8.32	+0.42
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.072
			PERT. R/O (IN.)	0.05	1.61	0.75	0.06	SIM = 31	W -0.00[illegible]
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP 0.008 SU -0.076
RW21	0.90	+50	Δ% OF R/O	-3.5	-0.2	-0.4	-3.5	-8.82	-0.43
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.070
			PERT. R/O (IN.)	0.04	1.61	0.75	0.06	SIM = 31	W -0.004
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.008 SU -0.070

TABLE 6-38

SENSITIVITY ANALYSIS OF BUZC (0.60)

SUBWATERSHED NO. 3 313 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW20	0.0	-100	Δ% OF R/O	+6.1	+0.1	+1.2	+4.6	+8.70	+0.74
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF = 23	F -0.061
			PERT. R/O (IN.)	0.10	2.17	0.53	0.12	SIM –	W -0.001
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP -0.012 SU -0.046
RW22	0.30	50	Δ% OF R/O	+2.8	0.0	+0.6	+2.2	+4.35	+0.30
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF = 23	F -0.056
			PERT. R/O (IN.)	0.10	2.17	0.52	0.12	SIM = 24	W -0.0
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP -0.012 WU -0.044
RW21	0.90	+50	Δ% OF R/O	-2.7	0.1	-0.6	-2.0	-4.35	0.40
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF = 23	F -0.054
			PERT. R/O (IN.)	0.09	2.17	0.52	0.11	SIM = 22	W -0.002
6-60			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP -0.012 SU -0.040

TABLE 6-39

SENSITIVITY ANALYSIS OF BUZC (0.60)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW20	0.0	−100	Δ% OF R/O	+4.3	+0.5	+0.8	+1.8	+25.0	+0.74
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.043
			PERT. R/O (IN.)	0.04	1.92	0.93	0.09		W −0.005 SP −0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.018
RW22	0.30	−50	Δ% OF R/O	+1.8	+0.2	+0.4	+0.8	+25.0	+0.34
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.036
			PERT. R/O (IN.)	0.04	1.91	0.93	0.09		W −0.004 SP −0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.016
RW21	0.90	+50	Δ% OF R/O	−1.3	−0.2	−0.4	−0.8	0.0	−0.29
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.026
			PERT. R/O (IN.)	0.04	1.90	0.92	0.09		W −0.004 SP −0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.016

TABLE 6-40

SENSITIVITY ANALYSIS OF BUZC (0.60)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW20	0.0	−100	Δ% OF R/O	+15.0	+0.3	+1.3	+7.0	+12.50	+0.85
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 45	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.150
			PERT. R/O (IN.)	0.03	1.56	0.62	0.14		W −0.003 SP −0.013
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU −0.070
RW22	0.30	−50	Δ% OF R/O	+8.1	+0.1	+0.6	+3.4	+10.0	+0.43
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 44	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.162
			PERT. R/O (IN.)	0.03	1.56	0.61	0.13		W −0.002 SP −0.012
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU −0.068
RW21	0.90	+50	Δ% OF R/O	−5.4	−0.2	−0.7	−3.2	−5.0	−0.45
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 38	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.108
			PERT. R/O (IN.)	0.03	1.55	0.61	0.12		W −0.004 SP −0.014
6-61			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU −0.064

TABLE 6-41

SENSITIVITY ANALYSIS OF BUZC (0.60)

SUBWATERSHED NO. 11   2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS				9/14/68 LOW FLOW	ANNUAL FLOW
				10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER		
RW20	0.0	−100	Δ% OF R/O	+2.4	+0.6	+2.0	+2.6	+22.2	+0.92
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 11	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.024
			PERT. R/O (IN.)	0.15	0.77	0.60	0.03		W −0.006 SP −0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU −0.026
RW22	0.30	−50	Δ% OF R/O	+1.1	+0.3	+1.0	+1.2	+11.11	+0.46
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.022
			PERT. R/O (IN.)	0.15	0.77	0.59	0.03		W −0.006 SP −0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU −0.024
RW21	0.90	+50	Δ% OF R/O	−1.0	−0.3	−1.0	−1.1	−11.11	−0.46
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F −0.020
			PERT. R/O (IN.)	0.15	0.77	0.58	0.03		W −0.006 SP −0.020
6-62			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU −0.022

TABLE 6-42

SENSITIVITY ANALYSIS OF BUZC -100% PERTURBATION (0.20 – 1.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O	0.0	0.0	0.0	–	–	–
D022			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0 W 0.0
			PERT. R/O	0.18	2.31	1.94	–	SIM = –	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU –
RUN ID			Δ% OF R/O	+12.9	+9.3	+0.6	+0.1	+13.3	+0.40
118			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.129 W -0.093
			PERT. R/O	0.037	0.043	0.922	0.043	SIM = 3.4	SP -0.006
			REF (R/F/R/O)	91	––	1.94	25		SU -0.001
RUN ID			Δ% OF R/O	+3.5	+0.4	+1.1	+3.5	+15.37	+0.95
RW20			Δ% OF MONTHLY R/O	OCT +2.26	JAN +0.50	APR +0.19	AUG +4.26	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.035 W -0.004
			PERT. R/O	0.10	0.98	0.49	0.07	SIM = 734	SP -0.011
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.035
RUN ID			Δ% OF R/O	+7.4	+0.3	+0.8	+7.9	+17.65	+0.88
RW20			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.074 W -0.003
			PERT. R/O	0.05	1.61	0.76	0.06	SIM = 40	SP -0.008
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.079
RUN ID			Δ% OF R/O	+6.1	+0.1	+1.2	+4.6	+8.70	+0.70
RW20			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.061 W -0.001
			PERT. R/O	0.10	2.17	0.53	0.12	SIM = 25	SP -0.012
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.046
RUN ID			Δ% OF R/O	+4.3	+0.5	+0.8	+1.8	+25.0	+0.74
RW20			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.043 W -0.005
			PERT. R/O	0.04	1.92	0.93	0.09	SIM = 5	SP -0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.018
RUN ID			Δ% OF R/O	+15.0	+0.3	+1.3	+7.0	+12.50	+0.85
RW20			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.150 W -0.003
			PERT. R/O	0.03	1.56	0.62	0.14	SIM = 45	SP -0.013
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.070
RUN ID			Δ% OF R/O	+2.4	+0.6	+2.0	+2.6	+22.2	+0.92
RW20			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.024 W -0.006
			PERT. R/O	0.15	0.77	0.60	0.03	SIM = 11	SP -0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.026

TABLE 6-43

SENSITIVITY ANALYSIS OF BUZC -50% PERTURBATION (0.20 - 1.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S023			Δ% OF R/O	0.0	0.0	0.0	+1.2	+1.27	+0.06
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0 W 0.0
			PERT. R/O	0.18	2.31	1.94	0.26	SIM = 8.0	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.024
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW22			Δ% OF R/O	+1.7	+0.2	+0.6	+1.7	+7.14	+0.48
			Δ% OF MONTHLY R/O	OCT +1.13	JAN +0.22	APR +0.12	AUG +1.94	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.034 W -0.004
			PERT. R/O	0.10	0.98	0.49	0.07	SIM = 690	SP -0.012
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.034
RUN ID RW22			Δ% OF R/O	+3.6	+0.1	+0.4	+3.8	+8.82	+0.42
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.072 W -0.002
			PERT. R/O	0.05	1.61	0.75	0.06	SIM = 37	SP -0.008
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.076
RUN ID RW22			Δ% OF R/O	+2.8	0.0	+0.6	+2.2	+4.35	+0.30
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.056 W 0.0
			PERT. R/O	0.10	2.17	0.52	0.12	SIM = 24	SP -0.012
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.044
RUN ID RW22			Δ% OF R/O	+1.8	+0.2	+0.4	+0.8	+25.0	+0.34
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.036 W -0.004
			PERT. R/O	0.04	1.91	0.93	0.09	SIM = 5	SP -0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.016
RUN ID RW22			Δ% OF R/O	+8.1	+0.1	+0.6	+3.4	+10.0	+0.43
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.162 W -0.002
			PERT. R/O	0.03	1.56	0.61	0.13	SIM = 44	SP -0.012
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.068
RUN ID RW22			Δ% OF R/O	+1.1	+0.3	+1.0	+1.2	+11.11	+0.46
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.022 W -0.006
			PERT. R/O	0.15	0.77	0.59	0.03	SIM = 10	SP -0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.024

TABLE 6-44

SENSITIVITY ANALYSIS OF BUZC +50% PERTURBATION (0.20 - 1.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S024 SMALL	365	45	Δ% OF R/O	+0.6	0.0	0.0	-1.3	0.0	-0.08
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
			REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.012 W 0.0
			PERT. R/O	0.18	2.31	1.94	0.25	SIM = 7.9	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU 0.026
RUN ID SNOW	277	32	Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
			REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW21 REGIONAL	22,248	41	Δ% OF R/O	-1.5	-0.2	-0.6	-1.5	-6.06	-0.44
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -0.25	APR -0.12	AUG -1.55	9/15/68	STORM U/S
			REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.030 W -0.004
			PERT. R/O	0.10	0.98	0.48	0.06	SIM = 605	SP -0.012
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.030
RUN ID RW21 SUB-WATERSHED NO. 1	2,326	50	Δ% OF R/O	-3.5	-0.2	-0.4	-3.5	-8.82	-0.46
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
			REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.070 W -0.004
			PERT. R/O	0.04	1.61	0.75	0.06	SIM = 31	SP -0.008
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.070
RUN ID RW21 SUB-WATERSHED NO. 3	813	50	Δ% OF R/O	-2.7	-0.1	-0.6	-2.0	-4.35	-0.40
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
			REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.054 W -0.002
			PERT. R/O	0.09	2.17	0.52	0.11	SIM = 22	SP -0.012
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.040
RUN ID RW21 SUB-WATERSHED NO. 5	1,064	37	Δ% OF R/O	-1.3	-0.2	-0.4	-0.8	0.0	-0.29
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
			REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.026 W -0.004
			PERT. R/O	0.04	1.90	0.92	0.90	SIM = 4	SP -0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.016
RUN ID RW21 SUB-WATERSHED NO. 7	1,111	40	Δ% OF R/O	-5.4	-0.2	-0.7	-3.2	-5.0	-0.45
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
			REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.108 W -0.004
			PERT. R/O	0.03	1.55	0.61	0.12	SIM = 38	SP -0.014
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.064
RUN ID RW21 SUB-WATERSHED NO. 11	2,551	30	Δ% OF R/O	-1.0	-0.3	-1.0	-1.1	-11.11	-0.46
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
			REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.020 W -0.006
			PERT. R/O	0.15	0.77	0.58	0.03	SIM = 8	SP -0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.022

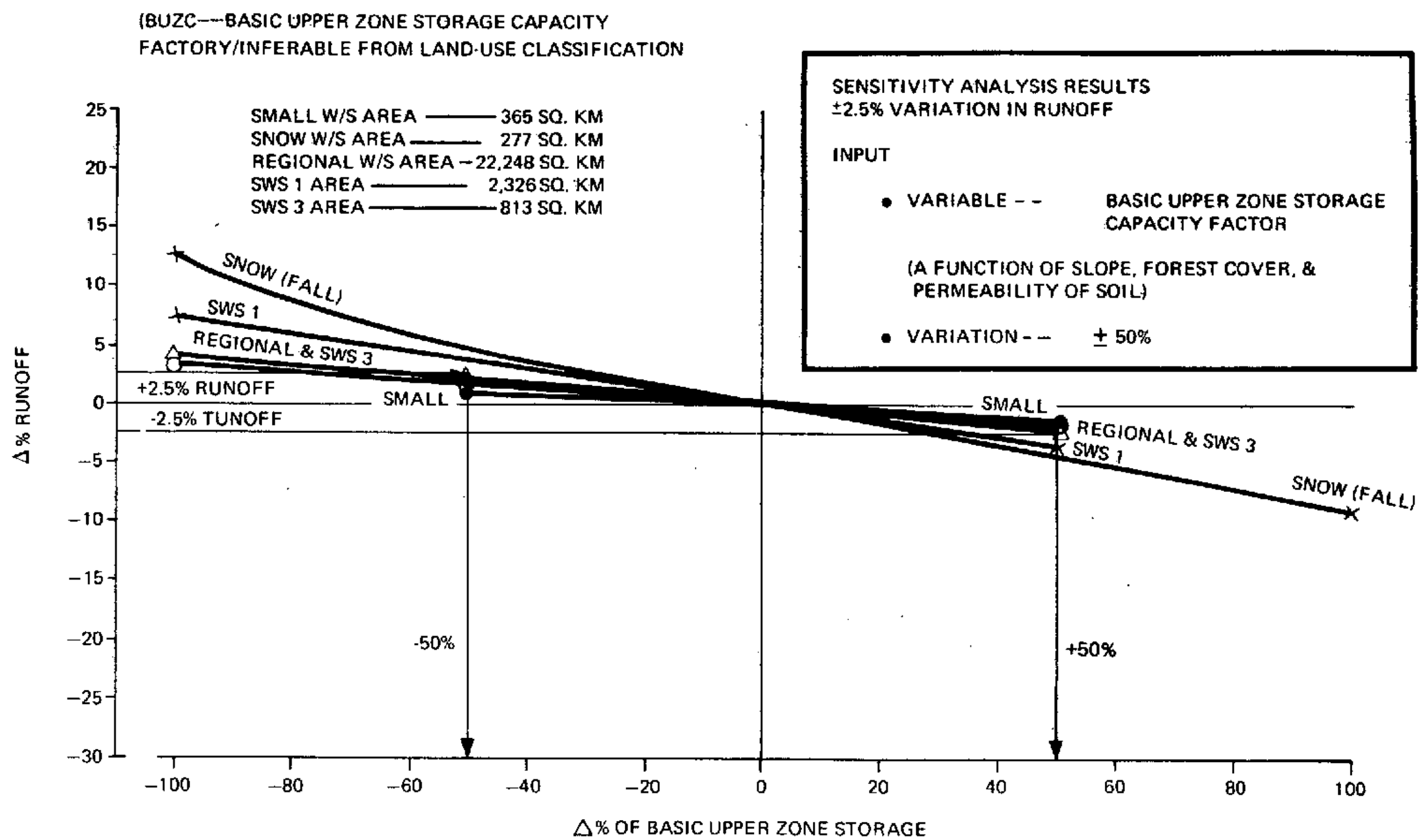


Figure 6-15. Basic Upper Zone Storage Study, Summer Storms

6.3.5 SUZC, SEASONAL UPPER ZONE CAPACITY FACTOR

SUZC is an index for estimating soil surface moisture storage capacity. Its primary purpose is to adjust the BUZC index for seasonal variation to account for increases caused by summer vegetation and cultivation. BUZC and SUZC are used to compute the upper soil zone nominal storage capacity (UZC).

$$UZC = SUZC\ (AEX90) + BUZC\ (e^{-2.7}\ \frac{LZS}{LZC})$$

where AEX90 is an antecedent evaporation index, LZS/LZC is an index of the moisture content of theunderlying soil.

The parameter LUZC can be inferred from land-use classification once a relationship similar to that maintained for BUZC is established. At present, it is quantified by calibration and fine tuning.

SUZC is a very influential parameter in low flows and during the summer season. An an example in subwatershed 1 the unit sensitivity in low flows is 4.52 and in a significant summer storm it is 1.8 for a -50% perturbation of the parameter. Results are shown in Tables 6-45 through 6-55 and Figure 6-16.

TABLE 6-46

SENSITIVITY ANALYSIS OF SUZC (0.20)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D027	0.001	−100	Δ% OF R/O	0.0	0.0	0.0	------	------	------
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	0.18	2.31	1.94	------	SIM = --	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU --
S028	0.10	−50	Δ% OF R/O	0.0	0.0	0.0	+3.7	+2.53	+0.37
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	0.18	2.31	1.94	0.26	SIM = 8.1	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU −0.074
S029	0.30	+50	Δ% OF R/O	0.0	0.0	−1.7	−12.3	−5.06	−1.88
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0
			PERT. R/O (IN)	0.18	2.31	1.90	0.22	SIM = 7.5	W 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP −0.034 SU −0.246
D030	0.40	+100	Δ% OF R/O	−8.57	0.0	−3.61	------	------	------
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F − 0.086
			PERT. R/O (IN)	0.16	2.31	1.87	------	SIM =	W 0.0
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		SP − 0.036 SU

TABLE 6-46

SENSITIVITY ANALYSIS OF SUZC (1.5)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
120	0.0	−100	Δ% OF R/O	+34.3	+10.9	+7.7	+42.7	400.0	+ 15.41
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F − 0.343
			PERT. R/O (IN.)	0.044	0.044	0.987	0.062	SIM = 15.0	W − 0.109
			REF (R/F/R/O)	91	--	1.94	25		SP − 0.077 SU − 0.427
121	3.0	+100	Δ% OF R/O	−15.8	−15.0	−12.9	−7.2	−33.33	− 9.98
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F − 0.158
			PERT. R/O (IN.)	0.028	0.033	0.798	0.040	SIM = 2.0	W − 0.150
6-68			REF (R/F/R/O)	91	--	1.94	25		SP − 0.129 SU − 0.072

TABLE 6-47

SENSITIVITY ANALYSIS OF SUZC (0.40)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW24	0.0	-100	Δ% OF R/O	+9.1	+0.8	+14.9	+79.6	+301.6	+9.91
			Δ% OF MONTHLY R/O	OCT +4.52	JAN +1.18	APR +0.54	AUG +98.45	REF = 644 SIM = 2586	STORM U/S F -0.091 W -0.008 SP -0.149 SU -0.796
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.11	0.99	0.56	0.12		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW26	0.20	- 50	Δ% OF R/O	+5.9	+0.5	+14.7	+31.1	+100.9	+5.67
			Δ% OF MONTHLY R/O	OCT +2.82	JAN +0.74	APR +0.46	AUG +36.82	REF = 644 SIM = 1294	STORM U/S F -0.118 W -0.010 SP -0.294 SU -0.622
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	0.99	0.56	0.08		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW25	0.60	+ 50	Δ% OF R/O	-3.8	-0.3	-13.8	-12.2	-35.87	-4.11
			Δ% OF MONTHLY R/O	OCT -1.69	JAN -0.44	APR -2.96	AUG -14.34	REF = 644 SIM = 413	STORM U/S F -0.076 W -0.006 SP -0.276 SU -0.244
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	0.98	0.42	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW27	0.95	+138	Δ% OF R/O	-8.1	-0.4	-32.1	-21.5	-64.60	-10.40
			Δ% OF MONTHLY R/O	OCT -3.95	JAN -1.29	APR -9.65	AUG -25.19	REF = 644 SIM = 228	STORM U/S F -0.059 W -0.003 SP -0.233 SU -0.156
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
6-69			PERT. R/O (IN)	0.09	0.98	0.33	0.05		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-48

SENSITIVITY ANALYSIS OF SUZC (0.40)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW24	0.0	-100	Δ% OF R/O	+32.3	+1.0	+15.4	+319.0	+891.18	+14.85
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.323
			PERT. R/O (IN.)	0.06	1.63	0.86	0.25	SIM = 337	W -0.010
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.154; SU -0.319
RW26	0.20	- 50	Δ% OF R/O	+19.9	+0.6	+14.3	+90.2	+226.47	+6.89
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.398
			PERT. R/O (IN.)	0.05	1.62	0.86	0.11	SIM = 111	W -0.012
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.286; SU -1.804
RW25	0.60	+ 50	Δ% OF R/O	-11.1	-0.2	-11.4	-34.9	-50.0	-5.33
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF =34	F -0.222
			PERT. R/O (IN.)	0.04	1.61	0.66	0.04	SIM = 17	W -0.004
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.228; SU -0.698
RW27	0.95	+138	Δ% OF R/O	-23.5	-0.9	-26.5	-55.2	-67.65	-12.80
			STORM R/F	2.16	1.91	3.49	2.79		STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	REF = 34	F -0.470
			PERT. R/O (IN.)	0.03	1.59	0.55	0.03	SIM = 11	W -0.018
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.530; SU -1.104

TABLE 6-49

SENSITIVITY ANALYSIS OF SUZC (0.40)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW24	0.0	-100	Δ% OF R/O	+24.7	+0.4	+27.8	+153.6	+1456.52	+12.87
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 358	STORM U/S F -0.247 W -0.004 SP -0.278 SU -1.536
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.12	2.18	0.67	0.30		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW26	0.20	- 50	Δ% OF R/O	+14.4	+0.3	+27.7	+49.7	+86.96	+7.06
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 43	STORM U/S F -0.288 W -0.006 SP -0.554 WU -0.994
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.11	2.18	0.67	0.18		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW25	0.60	+ 50	Δ% OF R/O	-9.4	0.0	-17.5	-18.0	-34.78	-4.97
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 15	STORM U/S F -0.188 W 0.0 SP -0.350 SU -0.360
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.09	2.17	0.43	0.10		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW27	0.95	+138	Δ% OF R/O	-19.6	+0.3	-35.7	-28.4	-52.17	-11.06
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 11	STORM U/S F -0.142 W +0.002 SP -0.259 SU -0.206
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.08	2.18	0.34	0.08		
6-71			REF (R/F/R/O)	26.4	1.43	3.26	18.9		

SENSITIVITY ANALYSIS OF SUZC (0.40)

SUBWATERSHED NO. 5 1,064 SQ. KM

TABLE 6-50

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
			Δ% OF R/O	+8.7	+0.8	+12.1	+21.8	250.0	+5.19
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW24	0.0	-100	REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 14	F -0.087 W -0.008
			PERT. R/O (IN.)	0.04	1.92	1.03	0.10		SP -0.121
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.218
			Δ% OF R/O	+3.9	+0.5	+12.0	+9.4	+100.0	+3.66
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW26	0.20	- 50	REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 8	F -0.078 W -0.010
			PERT. R/O (IN.)	0.04	1.92	1.03	0.09i		SP -0.240
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.188
			Δ% OF R/O	-2.1	-0.4	-13.3	-5.5	-25.0	-3.33
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW25	0.60	+ 50	REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 3	F -0.042 W -0.008
			PERT. R/O (IN.)	0.04	1.90	0.80	0.08		SP -0.266
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.110
			Δ% OF R/O	-3.9	-0.1	-29.7	-10.1	-50.0	-7.85
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW27	0.95	+138	REF. R/O (IN.)	0.036	1.907	0.921	0.086	REF = 4 SIM = 2	F -0.028 W 0.0
			PERT. R/O (IN.)	0.03	1.90	0.65	0.08		SP -0.215
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.073

SENSITIVITY ANALYSIS OF SUZC (0.40)

TABLE 6-51

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW24	0.0	-100	Δ% OF R/O	+35.7	+0.7	+13.3	+110.3	+167.5	+9.48
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 107	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F -0.357
			PERT. R/O (IN.)	0.04	1.57	0.69	0.27		W -0.007
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.133 SU -1.103
RW26	0.20	- 50	Δ% OF R/O	+24.4	+0.5	+13.2	+54.1	+77.5	+5.99
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 71	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F -0.488
			PERT. R/O (IN.)	0.04	1.56	0.69	0.20		W -0.010
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.264 SU -1.082
RW25	0.60	+ 50	Δ% OF R/O	-15.0	-0.3	-15.0	-28.2	-32.5	-4.68
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 27	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F -0.300
			PERT. R/O (IN.)	0.02	1.55	0.52	0.09		W -0.006
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.300 SU -0.564
RW27	0.95	+138	Δ% OF R/O	-32.9	-0.4	-34.4	-56.9	-62.5	-11.56
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 15	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F -0.238
			PERT. R/O (IN.)	0.02	1.55	0.40	0.05		W -0.003
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.249 SU -0.412

6-73

TABLE 6-52

SENSITIVITY ANALYSIS OF SUZC (0.40)

SUBWATERSHED NO. 11   2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW24	0.0	-100	Δ% OF R/O	+3.1	+0.7	+20.5	+53.5	+400.0	+5.79
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 45	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F -0.031
			PERT. R/O (IN.)	0.15	0.77	0.71	0.05		W -0.007
									SP -0.205
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.535
RW26	0.20	- 50	Δ% OF R/O	+1.9	+0.5	+20.4	+23.6	+144.4	+4.03
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 22	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F -0.038
			PERT. R/O (IN.)	0.15	0.77	0.71	0.04		W -0.010
									SP -0.408
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.472
RW25	0.60	+ 50	Δ% OF R/O	-1.3	-0.4	-17.7	-7.2	-22.2	-3.14
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 7	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F -0.026
			PERT. R/O (IN.)	0.15	0.77	0.48	0.03		W -0.008
									SP -0.354
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.144
RW27	0.95	+138	Δ% OF R/O	-2.7	-0.3	-37.7	-12.5	-33.33	-7.88
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 6	STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		F -0.020
			PERT. R/O (IN.)	0.15	0.77	0.37	0.03		W -0.002
									SP -0.273
6-74			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.091

TABLE 6-53

SENSITIVITY ANALYSIS OF SUZC -100% PERTURBATION (0.20 – 1.5)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID D027			Δ% OF R/O	0.0	0.0	0.0	–	–	–
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0 W 0.0
			PERT. R/O	0.18	2.31	1.94	–	SIM = –	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU –
RUN ID 120			Δ% OF R/O	+34.3	+10.9	+7.7	+42.7	+400.0	+15.41
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.343 W -0.109
			PERT. R/O	0.044	0.044	0.987	0.062	SIM = 15.0	SP -0.077
			REF (R/F/R/O)	91	––	1.94	25		SU -0.427
RUN ID RW24			Δ% OF R/O	+9.1	+0.8	+14.9	+79.6	+301.6	+9.91
			Δ% OF MONTHLY R/O	OCT +4.52	JAN +1.18	APR +0.54	AUG +98.45	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.091 W -0.008
			PERT. R/O	0.11	0.99	0.56	0.12	SIM = 2586	SP -0.149
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.796
RUN ID RW24			Δ% OF R/O	+32.3	+1.0	+15.4	+319.0	+891.18	+14.85
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.323 W -0.010
			PERT. R/O	0.06	1.63	0.86	0.25	SIM = 337	SP -0.154
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.319
RUN ID RW24			Δ% OF R/O	+24.7	+0.4	+27.8	+163.6	+1456.52	+12.87
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.247 W -0.004
			PERT. R/O	0.12	2.18	0.67	0.30	SIM = 358	SP -0.278
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -1.536
RUN ID RW24			Δ% OF R/O	+8.7	+0.8	+12.1	+21.8	+250.0	+5.19
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.087 W -0.008
			PERT. R/O	0.04	1.92	1.03	0.10	SIM = 14	SP -0.121
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.218
RUN ID RW24			Δ% OF R/O	+35.7	+0.7	+13.3	+110.3	+167.5	+9.48
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.357 W -0.007
			PERT. R/O	0.04	1.57	0.69	0.27	SIM = 107	SP -0.133
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -1.103
RUN ID RW24			Δ% OF R/O	+3.1	+0.7	+20.5	+53.5	+400.0	+5.79
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.031 W -0.007
			PERT. R/O	0.15	0.77	0.71	0.05	SIM = 45	SP -0.205
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.535

TABLE 6-54

SENSITIVITY ANALYSIS OF SUZC -50% PERTURBATION (0.20 – 1.5)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S028			Δ% OF R/O	0.0	0.0	0.0	+3.7	+2.53	+0.37
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0 W 0.0
			PERT. R/O	0.18	2.31	1.94	0.26	SIM = 8.1	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.074
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW26			Δ% OF R/O	+5.9	+0.5	+14.7	+31.1	+100.9	+5.67
			Δ% OF MONTHLY R/O	OCT +2.82	JAN +0.74	APR +0.46	AUG +36.82	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.118 W -0.010
			PERT. R/O	0.10	0.99	0.56	0.08	SIM = 1294	SP -0.294
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.622
RUN ID RW26			Δ% OF R/O	+19.9	+0.6	+14.3	+90.2	+226.47	+6.89
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.398 W -0.012
			PERT. R/O	0.05	1.62	0.86	0.11	SIM = 111	SP -0.286
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -1.804
RUN ID RW26			Δ% OF R/O	+14.4	+0.3	+27.7	+49.7	+86.96	+7.06
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.288 W -0.006
			PERT. R/O	0.11	2.18	0.67	0.18	SIM = 43	SP -0.554
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.994
RUN ID RW26			Δ% OF R/O	+3.9	+0.5	+12.0	+9.4	+100.0	+3.66
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.078 W -0.010
			PERT. R/O	0.04	1.92	1.03	0.09	SIM = 8	SP -0.240
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.188
RUN ID RW26			Δ% OF R/O	+24.4	+0.5	+13.2	+54.1	+77.5	+5.99
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.488 W -0.010
			PERT. R/O	0.04	1.56	0.69	0.20	SIM = 71	SP -0.264
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -1.082
RUN ID RW26			Δ% OF R/O	-1.3	-0.4	-17.7	-7.2	-22.2	-3.14
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.038 W -0.010
			PERT. R/O	0.15	0.77	0.48	0.03	SIM = 7	SP -0.408
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.472

SENSITIVITY ANALYSIS OF SMALL, SNOW & REGIONAL WATERSHEDS

TABLE 6-55

SUZC +50% PERTURBATION (0.20 – 1.5)

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S029			Δ% OF R/O	0.0	0.0	-1.7	-12.3	-5.06	-1.88
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F 0.0 W 0.0
			PERT. R/O	0.18	2.31	1.90	0.22	SIM = 7.5	SP -0.034
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.246
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S F
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW25			Δ% OF R/O	-3.8	-0.3	-13.8	-12.2	-35.87	-4.11
			Δ% OF MONTHLY R/O	OCT -1.69	JAN -0.44	APR -2.96	AUG -14.34	9/15/68	STORM U/S F -0.076
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	W -0.006
			PERT. R/O	0.10	0.98	0.42	0.06	SIM = 413	SP -0.276
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.244
RUN ID RW25			Δ% OF R/O	-11.1	-0.2	-11.4	-34.9	-50.0	-5.33
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S F -0.222
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	W -0.004
			PERT. R/O	0.04	1.61	0.66	0.04	SIM = 17	SP -0.228
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.698
RUN ID RW25			Δ% OF R/O	-9.4	0.0	-17.5	-18.0	-34.78	-4.97
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S F -0.188
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	W 0.0
			PERT. R/O	0.09	2.17	0.43	0.10	SIM = 15	SP -0.350
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.360
RUN ID RW25			Δ% OF R/O	-2.1	-0.4	-13.3	-5.5	-25.0	-3.33
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S F -0.042
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	W -0.008
			PERT. R/O	0.04	1.90	0.80	0.08	SIM = 3	SP -0.266
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.110
RUN ID RW25			Δ% OF R/O	-15.0	-0.3	-15.0	-28.2	-32.5	-4.68
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S F -0.300
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	W -0.006
			PERT. R/O	0.02	1.55	0.52	0.09	SIM = 27	SP -0.300
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.564
RUN ID RW25			Δ% OF R/O	-1.3	-0.4	-17.7	-7.2	-22.2	-3.14
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S F -0.026
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	W -0.008
			PERT. R/O	0.15	0.77	0.48	0.03	SIM = 7	SP -0.354
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.144

(SUZC — SEASONAL UPPER ZONE STORAGE CAPACITY FACTOR/INFERABLE FROM LAND USE CLASSIFICATION)

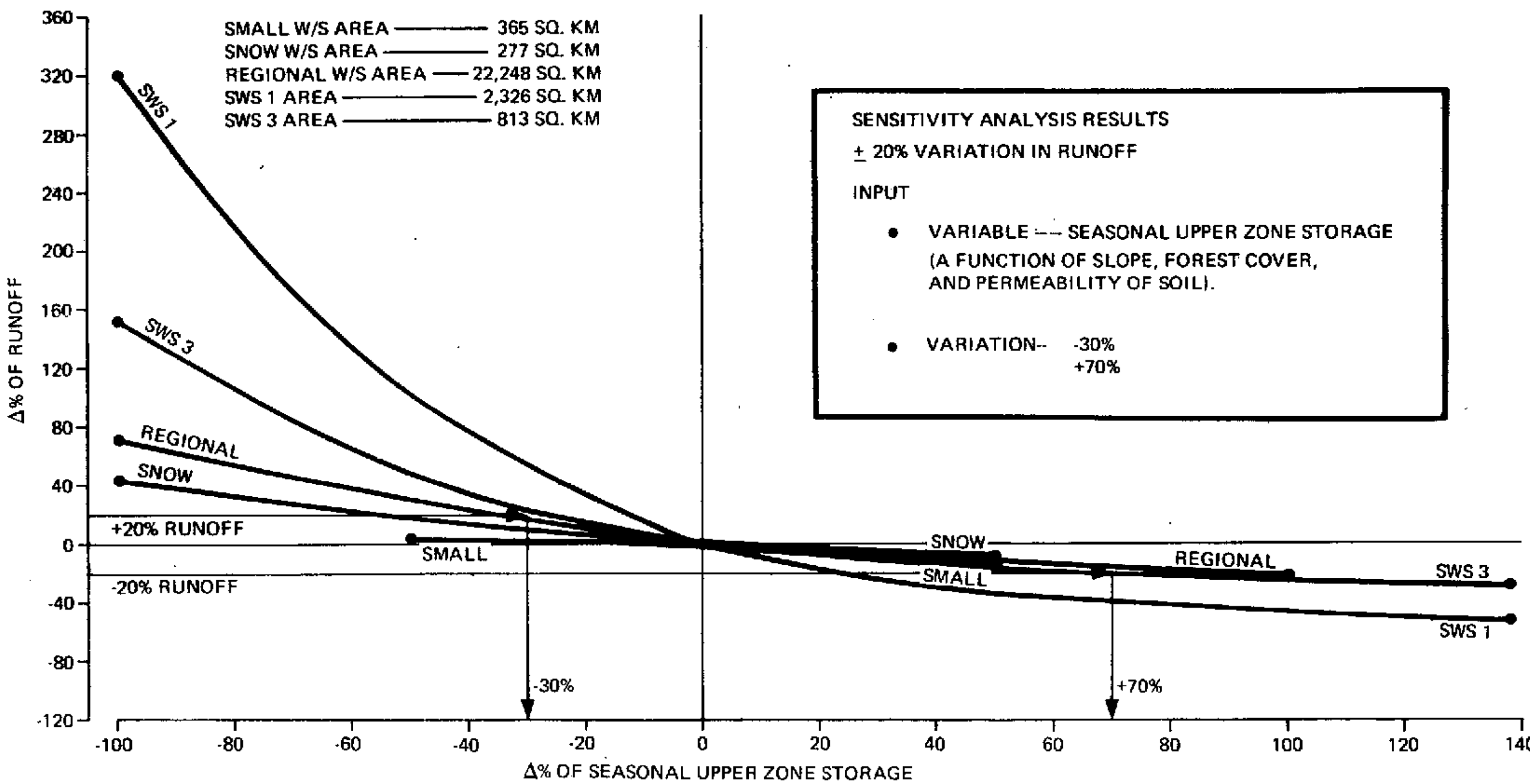


Figure 6-16. Seasonal Upper Zone Storage Study, Summer Storms

6.3.6 LZC, LOWER ZONE CAPACITY

LZC is the soil moisture storage capacity index which approximately equals the average water holding capacity of the soil. A larger ratio of soil moisture to capacity decreases the rate of infiltration, increases the availability of moisture to plant roots for evapotranspiration, and means more of the incoming moisture will percolate to groundwater. The percentage of either direct or delayed infiltration that enters the groundwater storage (the rest of the water is held in the soil) is a function of the dimensionless storage ratio LZS/LZC, where LZS is the quantity of water in the lower zone storage and LZC is the storage level at which fifty percent of all incoming moisture moves to groundwater storage.

Ross states that decreasing LZC in the model has the same effect as would reducing the ability of the soil to store water. Thus, the total synthesized runoff will increase. The sensitivity analysis that decreas LZC in the model increases the total annual flow, and the flows during fall, winter and spring. But summer flows and low flows are all diminished; this occurs in all watersheds analyzed. The explanation is in the calculations of CMIR which is the current maximum infiltration rate during the period of calculations.

$$\text{CMIR} = \tfrac{1}{4}\ \text{SIAM*BMIR/2**(4.*LZSR)}$$

where $\text{LZSR} = \dfrac{\text{LZS}}{\text{LZC}}$

As an example, consider subwatershed 7 with -50% perturbation in LZC (7.0 is the reference value).

	August 15	November 5
LZS	1.0	3.0
LZC	3.5	3.5
BMIR	12.0	12.0
SIAM	1.6	1.02
LZS/LZC	0.29	0.86

August 15 $\quad \text{CMIR} = \tfrac{1}{4} \times 1.6 \times 12.0/2^{**}1.14$

$$= 4.8/2.2 = 2.18$$

November 5 $CMIR = \frac{1}{4} \times 1.02 \times 12.0/2^{**}3.44$

$= 3.06/10.85 = 0.28$

The above calculations explain the change in polarity of the summer flows.

The parameter LZC can be inferred from land-use classification once a relationship of soil associations, slope of watershed, type and density of vegetation and forest cover is related to LZC. At present, it is quantified by calibration and manual adjustment.

Sensitivity analysis results indicate that LZC is a very influential parameter for all seasons. The unit sensitivity is 1.4 for the fall seasons and 0.5 for the winter seasons. Results are shown in Tables 6-56 through 6-65 and Figure 6-17.

TABLE 6-56

SENSITIVITY ANALYSIS OF LZC (4.0)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D032	0.001	-100	Δ% OF R/O	+1151.4	+24.9	+7.1	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = –	F -11.514
			PERT. R/O (IN)	2.19	2.89	2.08	–		W - 0.249
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP - 0.071 SU –
S033	2.0	- 50	Δ% OF R/O	+300.2	+13.1	+1.8	-33.4	-16.46	+7.34
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = 6.6	F -6.004
			PERT. R/O (IN)	0.70	2.62	1.97	0.17		W -0.261
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP -0.036 SU +0.668
S034	6.0	+ 50	Δ% OF R/O	-53.6	-12.7	-2.9	+32.7	+16.46	-6.82
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = 9.2	F -1.072
			PERT. R/O (IN)	0.08	2.02	1.88	0.34		W -0.254
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP -0.058 SU +0.654
D035	8.0	+100	Δ% OF R/O	-69.9	-24.7	-5.9	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = –	F -0.699
			PERT. R/O (IN)	0.05	1.74	1.82	–		W -0.247
6-81			REF (R/F/R/O)	17.9	3.19	1.47	8.3		SP -0.059 SU –

TABLE 6-57

SENSITIVITY ANALYSIS OF LZC (6.0)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/16/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
58	3.0	- 50	Δ% OF R/O	+93.7	+82.9	+43.4	+7.0	-20.0	+33.0
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.4	STORM U/S F -1.874 W -1.358 SP -0.838 SU -0.014
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.063	0.072	1.314	0.045		
			REF (R/F/R/O)	91	---	1.94	25		
59	4.8	- 20	Δ% OF R/O	+18.2	+27.9	+14.9	+3.5	-6.67	+12.18
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.6	STORM U/S F -0.910 W -1.400 SP -0.750 SU -0.17[illegible]
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.039	0.050	1.053	0.045		
			REF (R/F/R/O)	91	---	1.94	25		
60	7.2	+ 20	Δ% OF R/O	-8.4	-29.1	-13.4	-4.2	+3.33	-10.95
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S F -0.420 W -1.460 SP -0.670 SU -0.210
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.030	0.028	0.794	0.041		
			REF (R/F/R/O)	91	---	1.94	25		
61	9.0	+ 50	Δ% OF R/O	-14.7	-55.7	-31.9	-11.7	+3.33	-25.3
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S F -0.290 W -1.110 SP -0.340 SU -0.230
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.028	0.017	0.324	0.038		
6-82			REF (R/F/R/O)	91	--	1.94	25		

TABLE 6-58

SENSITIVITY ANALYSIS OF LZC (7.0)

REGIONAL WATERSHED 22,248 SQ KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
31	3.5	- 50	Δ% OF R/O	+35.2	+23.0	+2.0	-14.2	-27.17	+18.11
			Δ% OF MONTHLY R/O	OCT +15.25	JAN +27.02	APR +9.12	AUG -17.05	REF = 644 SIM = 469	STORM U/S F -0.704 W -0.460 SP -0.040 SU +0.284
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.134	1.205	0.497	0.055		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
30	6.3	- 10	Δ% OF R/O	+2.9	+4.5	+0.9	-2.6	-7.61	+3.42
			Δ% OF MONTHLY R/O	OCT +1.13	JAN +5.34	APR +1.88	AUG -3.10	REF = 644 SIM = 595	STORM U/S F -0.290 W -0.450 SP -0.090 SU +0.260
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	1.02	0.49	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
28	7.7	+ 10	Δ% OF R/O	-2.1	-4.5	-1.1	+2.3	+7.30	-3.34
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -5.28	APR -1.96	AUG +2.71	REF = 644 SIM = 691	STORM U/S F -0.210 W -0.450 SP -0.110 SU +0.230
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.099	0.94	0.48	0.07		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
29	10.5	+ 50	Δ% OF R/O	-7.0	-21.7	-6.3	+8.0	+32.14	-15.76
			Δ% OF MONTHLY R/O	OCT -2.82	JAN -25.4	APR -10.0	AUG +10.47	REF = 644 SIM = 851	STORM U/S F -0.140 W -0.434 SP -0.126 SU +0.160
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.092	0.767	0.457	0.069		
6-83			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-59

SENSITIVITY ANALYSIS OF LZC (6.0)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
31	3.0	- 50	Δ% OF R/O	+89.5	+25.1	-1.4	-36.4	-50.0	+15.83
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	SIM = 17	F -1.790
			PERT. R/O (IN.)	0.085	2.013	0.738	0.037		W -0.502
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP +0.028 SU +0.728
30	5.4	- 10	Δ% OF R/O	+7.7	+4.8	+0.6	-7.4	-14.71	+3.11
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	SIM = 29	F -0.770
			PERT. R/O (IN.)	0.05	1.69	0.75	0.05		W -0.480
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.060 SU +0.740
28	6.6	+ 10	Δ% OF R/O	-5.9	-4.8	-0.9	+6.9	+14.71	-3.03
			STORM R/F	2.16	1.91	3.49	2.79	REF =34	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	SIM = 39	F -0.590
			PERT. R/O (IN.)	0.04	1.53	0.74	0.06		W -0.480
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.090 SU +0.690
29	9.0	+ 50	Δ% OF R/O	-19.5	-23.1	-5.8	+28.3	+61.76	-14.67
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059	SIM = 55	F -0.390
			PERT. R/O (IN.)	0.036	1.237	0.706	0.075		W -0.462
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP -0.116 SU +0.566

TABLE 6-60

SENSITIVITY ANALYSIS OF LZC (6.0)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW 31	3.0	- 50	Δ% OF R/O	+90.6	+16.2	+0.3	-19.8	-39.13	+12.96
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 14	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F -1.812
			PERT. R/O (IN.)	0.181	2.521	0.523	0.094		W -0.324 SP -0.006
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.396
RW 30	5.4	- 10	Δ% OF R/O	+7.8	+3.1	+0.8	-4.3	-8.7	+2.51
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 21	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F -0.780
			PERT. R/O (IN.)	0.10	2.24	0.53	0.11		W -0.310 SP -0.080
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		WU +0.430
RW 28	6.6	+ 10	Δ% OF R/O	-5.8	-3.0	-0.9	+4.1	+8.70	-2.48
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 25	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F -0.580
			PERT. R/O (IN.)	0.09	2.10	0.52	0.12		W -0.300 SP -0.090
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.410
RW 29	9.0	+ 50	Δ% OF R/O	-18.7	-14.8	-5.6	+17.4	+34.78	-11.95
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 31	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F -0.374
			PERT. R/O (IN.)	0.077	1.848	0.492	0.138		W -0.296 SP -0.112
6-85			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.348

TABLE 6-61

SENSITIVITY ANALYSIS OF LZC (6.0)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW 31	3.0	- 50	Δ% OF R/O	+9.6	+23.6	+2.5	-5.3	-25.0	+15.24
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 3	STORM U/S F -0.192 W -0.472 SP -0.050 SU +0.106
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.039	2.358	0.944	0.082		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW 30	5.4	- 10	Δ% OF R/O	+0.9	+4.5	+0.9	-1.2	0.0	+2.98
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S F -0.090 W -0.450 SP -0.090 SU +0.024
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	1.99	0.93	0.9		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW 28	6.6	+ 10	Δ% OF R/O	-0.7	-4.4	-1.1	+1.2	+25.0	-2.92
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S F -0.070 W -0.440 SP -0.110 SU +0.120
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.036	1.82	0.91	0.09		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW 29	9.0	+ 50	Δ% OF R/O	-2.3	-20.9	-6.1	+5.6	+75.0	-13.85
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 7	STORM U/S F -0.046 W -0.418 SP -0.122 SU +0.112
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.035	1.508	0.865	0.091		
			REF (R/F/R/O)	30	1.06	1.97	25.8		

6-86

TABLE 6-62

SENSITIVITY ANALYSIS OF LZC (7.0)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW 31	3.5	- 50	Δ% OF R/O	+185.5	+30.3	+9.2	-39.9	-42.50	+19.58
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 23	STORM U/S F -3.710 W -0.606 SP -0.184 SU +0.798
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.084	2.029	0.666	0.076		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 30	6.3	- 10	Δ% OF R/O	+14.9	+5.6	+2.1	-8.0	-7.50	+3.68
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 37	STORM U/S F -1.490 W -0.112 SP -0.042 SU +0.800
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.64	0.62	0.12		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 28	7.7	+ 10	Δ% OF R/O	-9.1	-5.6	-2.3	+7.3	+7.50	-3.63
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 43	STORM U/S F -0.910 W -0.560 SP -0.230 SU +0.730
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.029	1.47	0.60	0.14		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW 29	10.5	+ 50	Δ% OF R/O	-29.2	-26.2	-11.4	+28.5	+30.0	-17.31
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 52	STORM U/S F -0.584 W -0.524 SP -0.228 SU +0.570
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.021	1.149	0.540	0.163		
6-87			REF (R/F/R/O)	54.5	1.77	3.14	23.2		

TABLE 6-63

SENSITIVITY ANALYSIS OF LZC (6.0)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW 31	3.0	-50	Δ% OF R/O	+11.4	+31.7	+6.4	-11.3	-33.33	+21.92
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 6	STORM U/S F -0.228 W -0.634 SP -0.128 SU +0.226
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.167	1.013	0.625	0.028		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW 30	5.4	- 10	Δ% OF R/O	+0.9	+5.9	+1.7	-1.6	-11.11	+4.13
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S F -0.090 W -0.118 SP -0.034 SU +0.032
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.82	0.60	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW 28	6.6	+ 10	Δ% OF R/O	-0.7	-5.9	-1.8	+1.2	+11.11	-3.99
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S F -0.070 W -0.118 SP -0.036 SU +0.024
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.72	0.58	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW 29	9.0	+ 50	Δ% OF R/O	-2.2	-28.7	-9.8	+2.9	+33.33	-18.46
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 12	STORM U/S F -0.044 W -0.574 SP -0.196 SU -0.058
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.147	0.548	0.530	0.032		
6-88			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

TABLE 6-64

SENSITIVITY ANALYSIS OF LZC -50% PERTURBATION (4.0 - 7.0)

SMALL, SNOW & REGIONAL WATERSHEDS

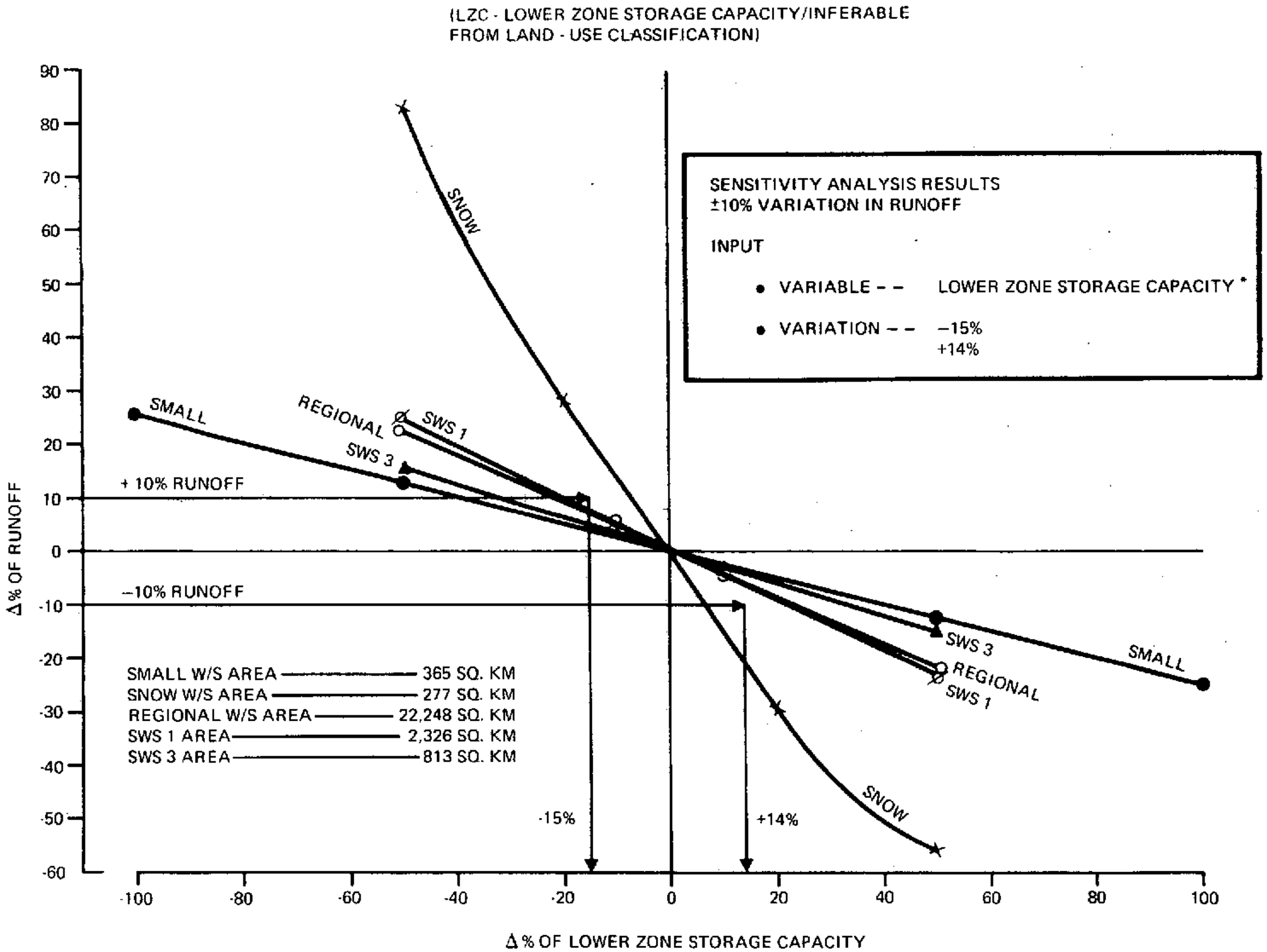
WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S033			Δ% OF R/O	+300.2	+13.1	+1.8	-33.4	-16.46	+7.34
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -6.004
			PERT. R/O	0.70	2.62	1.97	0.17	SIM = 6.6	W -0.261
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP -0.036 SU +0.668
RUN ID 58			Δ% OF R/O	+93.7	+82.9	+43.4	+7.0	-20.0	+33.0
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -1.874
			PERT. R/O	0.063	0.072	1.314	0.046	SIM = 2.4	W -1.658
			REF (R/F/R/O)	91	--	1.94	25		SP -0.868 SU -0.014
RUN ID RW31			Δ% OF R/O	+35.2	+23.0	+2.0	-14.2	-27.17	+18.11
			Δ% OF MONTHLY R/O	OCT +15.25	JAN +27.02	APR +9.12	AUG -17.05	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.204
			PERT. R/O	0.134	1.205	0.497	0.055	SIM = 469	W -0.460
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SP -0.040 SU -0.284
RUN ID RW31			Δ% OF R/O	+89.5	+25.1	-1.4	-36.4	-50.0	+15.83
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -1.790
			PERT. R/O	0.085	2.013	0.738	0.037	SIM = 17	W -0.502
			REF (R/F/R/O)	48	1.18	4.65	46.5		SP +0.028 SU +0.728
RUN ID RW31			Δ% OF R/O	+90.6	+16.2	+0.3	-19.8	-39.13	+12.96
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -1.812
			PERT. R/O	0.181	2.521	0.523	0.094	SIM = 14	W -0.324
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP -0.006 SU +0.396
RUN ID RW31			Δ% OF R/O	+9.6	+23.6	+2.5	-5.3	-25.0	+15.24
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.192
			PERT. R/O	0.039	2.358	0.944	0.082	SIM = 3	W -0.472
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP -0.050 SU +0.106
RUN ID RW31			Δ% OF R/O	+185.5	+30.3	+9.2	-39.9	-42.50	+19.58
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -3.710
			PERT. R/O	0.084	2.029	0.666	0.076	SIM = 23	W -0.606
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.184 SU +0.798
RUN ID RW31			Δ% OF R/O	+11.4	+31.7	+6.4	-11.3	-33.33	+21.92
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.228
			PERT. R/O	0.167	1.013	0.625	0.028	SIM = 6	W -0.634
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP -0.128 SU +0.226

TABLE 6-65

SENSITIVITY ANALYSIS OF LZC +50% PERTURBATION (4.0 – 7.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S034			Δ% OF R/O	-53.6	-12.7	-2.9	+32.7	+16.46	-6.82
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -1.072 W -0.254
			PERT. R/O	0.08	2.02	1.88	0.34	SIM = 9.2	SP -0.058
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +0.654
RUN ID 61			Δ% OF R/O	-14.7	-55.7	-31.9	-11.7	+3.33	-25.3
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.290 W -1.110
			PERT. R/O	0.028	0.017	0.624	0.038	SIM = 3.1	SP -0.640
			REF (R/F/R/O)	91	—	1.94	25		SU -0.230
RUN ID RW29			Δ% OF R/O	-7.0	-21.7	-6.3	+8.0	+32.14	-15.76
			Δ% OF MONTHLY R/O	OCT -2.82	JAN -25.4	APR -10.0	AUG +10.47	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.140 W -0.434
			PERT. R/O	0.092	0.767	0.457	0.069	SIM = 851	SP -0.126
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.160
RUN ID RW29			Δ% OF R/O	-19.5	-23.1	-5.8	+28.3	+61.76	-14.67
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.390 W -0.462
			PERT. R/O	0.036	1.237	0.706	0.075	SIM = 55	SP -0.116
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.566
RUN ID RW29			Δ% OF R/O	-18.7	-14.8	-5.6	+17.4	+34.78	-11.95
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.374 W -0.296
			PERT. R/O	0.077	1.848	0.492	0.138	SIM = 31	SP -0.112
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.348
RUN ID RW29			Δ% OF R/O	-2.3	-20.9	-6.1	+5.6	+75.0	-13.85
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.046 W -0.418
			PERT. R/O	0.035	1.508	0.865	0.091	SIM = 7	SP -0.122
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.112
RUN ID RW29			Δ% OF R/O	-29.2	-26.2	-11.4	+28.5	+30.0	-17.31
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.584 W -0.524
			PERT. R/O	0.021	1.149	0.540	0.163	SIM = 52	SP -0.228
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU +0.570
RUN ID RW29			Δ% OF R/O	-2.2	-28.7	-9.8	+2.9	+33.33	-18.46
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.044 W -0.574
			PERT. R/O	0.147	0.548	0.530	0.032	SIM = 12	SP -0.196
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.058



* A FUNCTION OF SOIL ASSOCIATION, SLOPE, TYPE OF VEGITATION AND FOREST COVERS

Figure 6-17. Lower Zone Storage Capacity Study, Winter Storms

6.3.7 ETLF, EVAPOTRANSPIRATION LOSS FACTOR

ETLF is an index used to estimate the maximum rate of evapotranspiration which could occur within the watershed under current conditions of soil moisture content. This maximum rate is then used to estimate current actual evapotranspiration. A higher value of ETLF should be used for watersheds containing many large trees because transpiration will continue from trees long after more shallow rooted vegetation withers. The parameter ETLF logically relates to verland slope and forest cover. Forest cover enters because trees are the primary deep rooted plants able to keep transpiration continuing during long dry periods, and slope enters because moisture would normally drain faster by gravity from steeper slopes and thus be available for a lesser time to plants for transpiration. Watersheds with steep slopes are also more likely to have large areas in shaded north slopes where evaporation rates are lower.

The parameter ETLF can be indirectly obtainable from land-use classification after a good relationship between slope and forest cover to ETLF is established. It is presently quantified by calibration and manual adjustment.

Sensitivity analysis results indicate that ETLF is influential throughout the year, but during summer flows and low flows it is very sensitive. The average unit sensitivity is 0.14 for the fall seasons and 1.03 for the summer seasons. Results are shown in Tables 6-66 through 6-75 and Figure 6-18.

TABLE 6-66

SENSITIVITY ANALYSIS OF ETLF (0.20)

SMALL WATERSHED 365 SQ. KM.

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D036	0.001	−100	Δ% OF R/O	+24.6	+1.6	+3.5	----	----	----
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = --	STORM U/S F −0.246 W −0.016 SP −0.035 SU ---
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.22	2.35	2.01	----		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S037	0.10	−50	Δ% OF R/O	+9.4	+0.4	+1.1	+89.7	+43.0	+4.68
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 11.3	STORM U/S F −0.188 W −0.008 SP −0.022 SU −1.794
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.19	2.32	1.96	0.48		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S038	0.30	+50	Δ% OF R/O	−5.9	−0.2	−0.4	−30.2	−20.3	−2.17
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 6.3	STORM U/S F +0.118 W +0.004 SP +0.008 SU +0.604
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.17	2.31	1.93	0.18		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D039	0.40	+100	Δ% OF R/O	−9.8	−0.4	−0.6	----	----	----
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = --	STORM U/S F −0.098 W −0.004 SP −0.006 SU ---
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.16	2.30	1.93	----		
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		
D040	1.0	+400	Δ% OF R/O	−16.6	−0.7	−1.0	----	----	----
			STORM R/F	3.13	1.38	2.87	2.16	REF = 7.9 SIM = --	STORM U/S F −0.042 W −0.002 SP −0.002 SU ---
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.15	2.30	1.92	----		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		

6-93

TABLE 6-67

SENSITIVITY ANALYSIS OF ETLF (0.30)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
RW16	0.15	−50	Δ% OF R/O	+1.6	+2.0	+0.8	+4.2	+113.3	+2.4
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0 SIM = 6.4	F −0.032
			PERT. R/O (IN.)	0.033	0.040	0.923	0.045		W −0.040 SP −0.016
			REF (R/F/R/O)	91	—	1.94	25		SU −0.084
RW17	0.225	−25	Δ% OF R/O	+0.5	+0.7	+0.3	+1.2	+30.0	+0.77
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0 SIM = 3.9	F −0.020 W −0.028
			PERT. R/O (IN.)	0.033	0.040	0.919	0.044		SP −0.012
			REF (R/F/R/O)	91	—	1.94	25		SU −0.048
RW18	0.375	+25	Δ% OF R/O	−0.3	−0.4	−0.2	−0.6	0.0	−0.43
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0 SIM = 3.0	F −0.010 W −0.016
			PERT. R/O (IN.)	0.032	0.039	0.915	0.043		SP −0.008
			REF (R/F/R/O)	91	—	1.94	25		SU −0.024
RW19	0.45	+50	Δ% OF R/O	−0.5	−0.7	−0.3	−1.0	−20.0	−0.69
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0 SIM = 2.4	F −0.010 W −0.014
			PERT. R/O (IN.)	0.033	0.039	0.914	0.043		SP −0.006
			REF (R/F/R/O)	91	—	1.94	25		SU −0.020

TABLE 6-68

SENSITIVITY ANALYSIS OF ETLF (0.20)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW32	0.0	−100	Δ% OF R/O	+9.1	+8.3	+8.6	+79.3	+429.5	+16.7
			Δ% OF MONTHLY R/O	OCT +3.95	JAN +12.62	APR +3.77	AUG +106.6		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F −0.091
			PERT. R/O (IN)	0.11	1.06	0.53	0.11	SIM = 3410	W −0.083 SP −0.086
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU −0.793
RW 34	0.10	−50	Δ% OF R/O	+3.7	+3.2	+2.2	+32.0	+152.2	+5.84
			Δ% OF MONTHLY R/O	OCT +1.69	JAN +4.73	APR +0.88	AUG +41.1		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F -0.074
			PERT. R/O (IN)	0.102	1.011	0.498	0.085	SIM = 1624	W -0.064 SP -0.044
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.640
RW 33	0.30	+50	Δ% OF R/O	-2.5	-2.1	-0.9	-11.1	-41.6	-2.92
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -3.05	APR -0.54	AUG -13.6		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F -0.050 W −0.042
			PERT. R/O (IN)	0.096	0.960	0.483	0.057	SIM = 376	SP -0.018
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.222
RW 35	0.95	+375	Δ% OF R/O	-6.7	-6.8	-2.4	-21.0	-71.3	-7.91
			Δ% OF MONTHLY R/O	OCT -2.82	JAN -9.77	APR -1.62	AUG -25.58		STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644	F -0.018 W -0.018
			PERT. R/O (IN)	0.09	0.91	0.48	0.05	SIM = 185	SP -0.006
6-95			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU -0.056

TABLE 6-69

SENSITIVITY ANALYSIS OF ETLF (0.20)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ % PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW 32	0.0	-100	Δ% OF R/O	+24.2	+7.5	+18.8	+249	+573.5	+17.6
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 229	STORM U/S F -0.242 W -0.075 SP -0.188 SU -0.249
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.06	1.73	0.89	0.20		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW 34	0.10	-50	Δ% OF R/O	+8.8	+2.9	+4.8	+105.5	+238.2	+7.06
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 115	STORM U/S F -0.176 W -0.058 SP -0.096 SU -0.211
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.049	1.657	0.785	0.121		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW 33	0.30	+50	Δ% OF R/O	-6.6	-2.0	-1.8	-35.2	-50.0	-3.43
			STORM R/F	2.16	1.91	3.49	2.79	REF =34 SIM = 17	STORM U/S F -0.132 W -0.040 SP -0.036 SU -0.704
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.042	1.577	0.736	0.038		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW 35	0.95	+375	Δ% OF R/O	-21.9	-7.2	-4.7	-62.3	-79.4	-9.68
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 7	STORM U/S F -0.058 W -0.019 SP -0.013 SU -0.166
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.03	1.49	0.71	0.02		
			REF (R/F/R/O)	48	1.18	4.65	46.5		

TABLE 6-70

SENSITIVITY ANALYSIS OF ETLF (0.20)
SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW 32	0.0	−100	Δ% OF R/O	+19.5	+2.9	+14.2	+162.5	+195.7	+14.7
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 68	STORM U/S F −0.195 W −0.029 SP −0.142 SU −1.625
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.11	2.23	0.60	0.31		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW 34	0.10	−50	Δ% OF R/O	+8.4	+1.2	+3.5	+56.4	+104.4	+5.38
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 47	STORM U/S F −0.168 W −0.024 SP −0.070 WU−1.308
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.103	2.196	0.539	0.184		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW 33	0.30	+50	Δ% OF R/O	−6.1	−0.8	−1.3	−15.9	−30.4	−2.40
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 16	STORM U/S F −0.122 W −0.016 SP −0.026 SU −0.318
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.089	2.152	0.515	0.099		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW 35	0.95	+375	Δ% OF R/O	−19.8	−3.0	−3.3	−27.5	−56.5	−6.78
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 10	STORM U/S F −0.053 W −0.008 SP −0.009 SU −0.074
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.08	2.11	0.50	0.09		
6-97			REF (R/F/R/O)	26.4	1.43	3.26	18.9		

TABLE 6-71

SENSITIVITY ANALYSIS OF ETLF (0.20)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW 32	0.0	−100	Δ% OF R/O	+2.8	+5.9	+7.1	+93.3	+825.0	+9.4
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM =37	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.028 W −0.059
			PERT. R/O (IN.)	0.04	2.02	0.99	0.17		SP −0.071
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.933
RW 34	0.10	−50	Δ% OF R/O	+1.2	+2.4	+1.4	+20.5	+225.0	+3.29
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 13	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.024 W −0.048
			PERT. R/O (IN.)	0.036	1.954	0.934	0.104		SP −0.028
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.410
RW 33	0.30	+50	Δ% OF R/O	−0.9	−1.6	−0.6	−3.8	−25.0	−1.80
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 3	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.018 W −0.032
			PERT. R/O (IN.)	0.036	1.876	0.916	0.083		SP −0.012
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.076
RW 35	0.95	+375	Δ% OF R/O	−2.9	−5.8	−1.6	−6.5	−50.0	−5.72
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 2	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.008 W −0.015
			PERT. R/O (IN.)	0.03	1.80	0.91	0.08		SP −0.004
6-98			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.017

TABLE 6-72

SENSITIVITY ANALYSIS OF ETLF (0.20)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW 32	0.0	-100	Δ% OF R/O	+30.9	+10.3	+11.9	+386.7	+270.0	+18.9
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F -0.309
			PERT. R/O (IN.)	0.04	1.72	0.68	0.62	SIM = 148	W -0.103
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.119
									SU -3.867
RW 34	0.10	- 50	Δ% OF R/O	+14.6	+3.7	+2.7	+126.1	+125.0	+7.35
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F -0.292
			PERT. R/O (IN.)	0.034	1.615	0.626	0.287	SIM = 90	W -0.074
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.054
									SU -0.522
RW 33	0.30	+ 50	Δ% OF R/O	-8.6	-2.3	-1.3	-39.4	-40.0	-3.65
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F -0.172
			PERT. R/O (IN.)	0.027	1.521	0.602	0.077	SIM = 24	W -0.046
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.026
									SU -0.788
RW 35	0.95	+375	Δ% OF R/O	-21.0	-6.2	-3.0	-73.5	-82.5	-8.63
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F -0.056
			PERT. R/O (IN.)	0.02	1.46	0.59	0.03	SIM = 7	W -0.017
6-99			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP -0.008
									SU -0.196

TABLE 6-73

SENSITIVITY ANALYSIS OF ETLF (0.20)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW 32	0.0	-100	Δ% OF R/O	+3.9	+11.7	+7.7	+44.3	+444.4	+12.3
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F -0.039
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = 49	W -0.117
			PERT. R/O (IN.)	0.16	0.86	0.63	0.05		SP -0.077
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.443
RW 34	0.10	- 50	Δ% OF R/O	+1.6	+4.2	+1.9	+17.7	+144.4	+4.17
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F -0.032
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = 22	W -0.084
			PERT. R/O (IN.)	0.153	0.802	0.599	0.037		SP -0.038
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.354
RW 33	0.30	+ 50	Δ% OF R/O	-0.9	-2.6	-0.8	-5.9	-22.2	-2.33
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F -0.018
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = 7	W -0.052
			PERT. R/O (IN.)	0.149	0.750	0.583	0.029		SP -0.016
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.118
RW 35	0.95	+375	Δ% OF R/O	-2.0	-6.9	-2.1	-11.7	-44.4	-5.89
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F -0.005
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = 5	W -0.018
			PERT. R/O (IN.)	0.15	0.72	0.58	0.03		SP -0.006
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.031

6-100

TABLE 6-74

SENSITIVITY ANALYSIS OF ETLF +50% PERTURBATION (0.20 – 0.30) SMALL, SNOW & REGIONAL WATERSHEDS

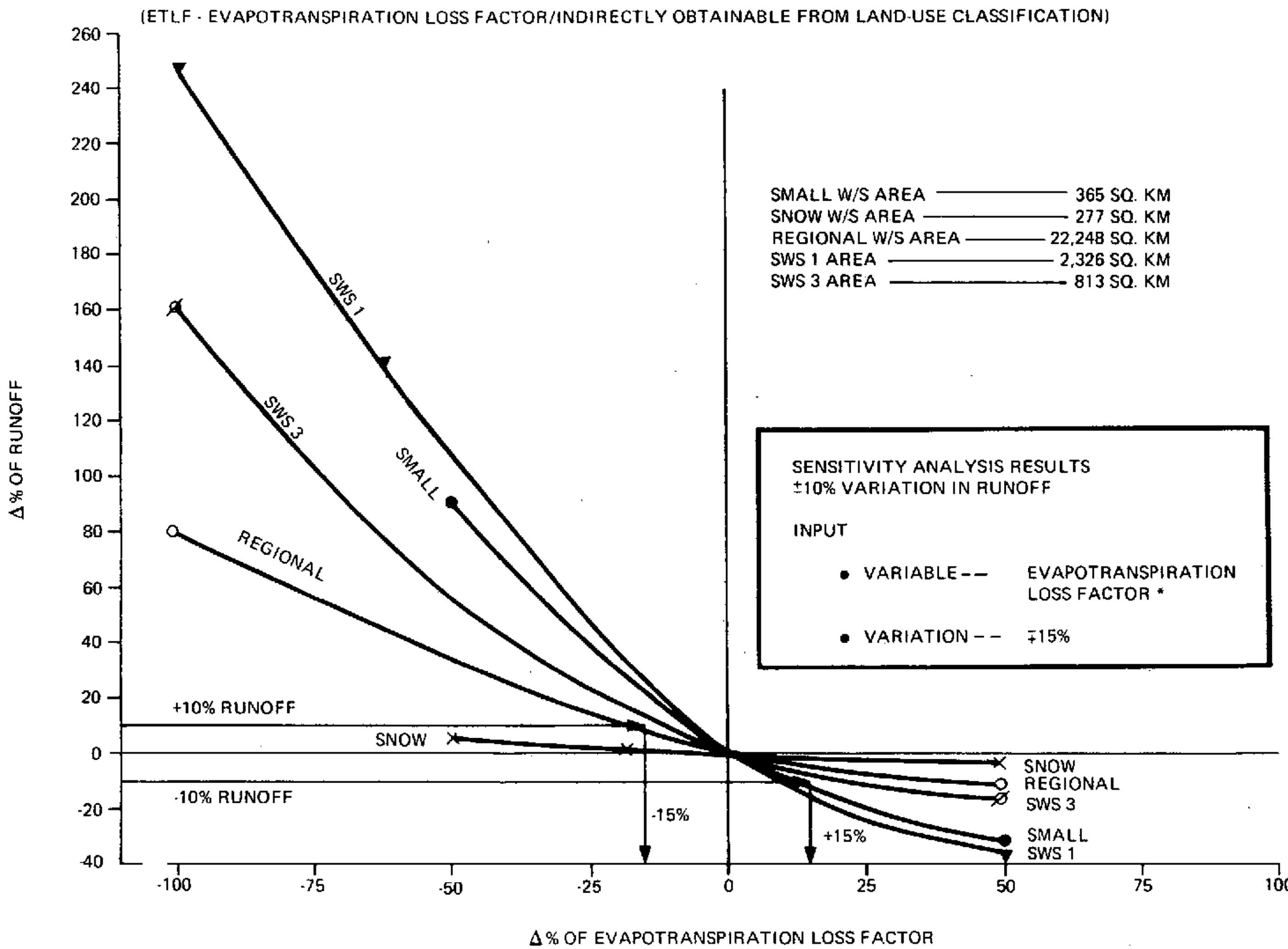
WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S038 SMALL	365	45	Δ% OF R/O	-5.9	-0.2	-0.4	-30.2	-20.3	-2.17
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
			REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.118
			PERT. R/O	0.17	2.31	1.93	0.18	SIM = 6.3	W +0.004 SP +0.008
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +0.604
RUN ID 19 SNOW	277	32	Δ% OF R/O	-0.5	-0.7	-0.3	-1.0	-20.0	-0.69
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
			REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.010
			PERT. R/O	0.033	0.039	0.914	0.043	SIM = 2.4	W -0.014 SP -0.006
			REF (R/F/R/O)	91	---	1.94	25		SU -0.020
RUN ID RW 33 REGIONAL	22,248	41	Δ% OF R/O	-2.5	-2.1	-0.9	-11.1	-41.6	-2.92
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -3.05	APR -0.54	AUG -13.6	9/15/68	STORM U/S
			REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.050
			PERT. R/O	0.096	0.960	0.483	0.057	SIM = 376	W -0.042 SP -0.018
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.222
RUN ID RW 33 SUB-WATERSHED NO. 1	2,326	50	Δ% OF R/O	-6.6	-2.0	-1.8	-35.2	-50.0	-3.43
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
			REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.132
			PERT. R/O	0.042	1.577	0.736	0.038	SIM = 17	W -0.040 SP -0.036
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.704
RUN ID RW 33 SUB-WATERSHED NO. 3	813	50	Δ% OF R/O	-6.1	-0.8	-1.3	-15.9	-30.4	-2.40
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
			REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.122
			PERT. R/O	0.089	2.152	0.515	0.099	SIM = 16	W -0.016 SP -0.026
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.318
RUN ID RW 33 SUB-WATERSHED NO. 5	1,064	37	Δ% OF R/O	-0.9	-1.6	-0.6	-3.8	-25.0	-1.80
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
			REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.018
			PERT. R/O	0.036	1.876	0.916	0.083	SIM = 3	W -0.032 SP -0.012
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.076
RUN ID RW 33 SUB-WATERSHED NO. 7	1,111	40	Δ% OF R/O	-8.6	-2.3	-1.3	-39.4	-40.0	-3.65
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
			REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.172
			PERT. R/O	0.027	1.521	0.602	0.077	SIM = 24	W -0.046 SP -0.026
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.788
RUN ID RW 33 SUB-WATERSHED NO. 11	2,551	30	Δ% OF R/O	-0.9	-2.6	-0.8	-5.9	-22.2	-2.33
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
			REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.018
			PERT. R/O	0.149	0.750	0.583	0.029	SIM = 7	W -0.052 SP -0.016
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.118

TABLE 6-75

SENSITIVITY ANALYSIS OF ETLF -50% PERTURBATION (0.20 – 0.30)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID S037			Δ% OF R/O	+9.4	+0.4	+1.1	+89.7	+43.0	+4.68
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.188
			PERT. R/O	0.19	2.32	1.96	0.48	SIM = 11.3	W -0.008 SP -0.022
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -1.794
RUN ID 16			Δ% OF R/O	+1.6	+2.0	+0.8	+4.2	+113.3	+2.4
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.032
			PERT. R/O	0.033	0.040	0.923	0.045	SIM = 6.4	W -0.040 SP -0.016
			REF (R/F/R/O)	91	––	1.94	25		SU -0.084
RUN ID RW 34			Δ% OF R/O	+3.7	+3.2	+2.2	+32.0	+152.2	+5.84
			Δ% OF MONTHLY R/O	OCT +1.69	JAN +4.73	APR +0.88	AUG +41.1	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.074
			PERT. R/O	0.102	1.011	0.498	0.085	SIM = 1624	W -0.064 SP -0.044
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.640
RUN ID RW 34			Δ% OF R/O	+8.8	+2.9	+4.8	+105.5	+238.2	+7.86
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.176
			PERT. R/O	0.049	1.657	0.785	0.121	SIM = 115	W -0.058 SP -0.096
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.211
RUN ID RW 34			Δ% OF R/O	+8.4	+1.2	+3.5	+56.4	+104.4	+5.38
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.168
			PERT. R/O	0.103	2.196	0.539	0.184	SIM = 47	W -0.024 SP -0.070
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -1.308
RUN ID RW 34			Δ% OF R/O	+1.2	+2.4	+1.4	+20.5	+225.0	+3.29
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.024
			PERT. R/O	0.036	1.954	0.934	0.104	SIM = 13	W -0.048 SP -0.028
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.410
RUN ID RW 34			Δ% OF R/O	+14.6	+3.7	+2.7	+126.1	+125.0	+7.35
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.292
			PERT. R/O	0.034	1.615	0.626	0.287	SIM = 90	W -0.074 SP -0.054
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -2.522
RUN ID RW 34			Δ% OF R/O	+1.6	+4.2	+1.9	+17.7	+144.0	+4.17
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.032
			PERT. R/O	0.153	0.802	0.599	0.037	SIM = 22	W -0.084 SP -0.038
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.354



* A FUNCTION OF TYPE AND DENSITY OF VEGITATIVE COVER

Figure 6-18. Evapotranspiration Loss Factor Study, Summer Storms

6.3.8 SIAC, SEASONAL INFILTRATION ADJUSTMENT FACTOR

SIAC is an index to adjust infiltration rates for seasonal variation. It logically varies with seasonal variation in vegetative cover. Growing root systems and waste vegetative matter loosen the soil surface and growing plants take water from the soil and thereby cause fine soils to more quickly dry and crack during dry periods.

The parameter SIAC can be indirectly obtainable from land-use classification after a relationship of the type and density of vegetation and forest covers are related to SIAC parameter. At present, it is quantified by calibration and manual adjustment.

Sensitivity analysis shows that SIAC is most influential during the winter season, when its average unit sensitivity is 0.11. Results appear in Tables 6-76 through 6-86 and Figure 6-19.

SENSITIVITY ANALYSIS OF SIAC (0.26)

SMALL WATERSHED 365 SQ. KM

TABLE 6-76

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D053	0.001	−100	Δ% OF R/O	−2.86	−9.52	+1.55	----	----	----
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = ----	STORM U/S F +0.029 W +0.095 SP −0.016 SU ----
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.17	2.09	1.97	----		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S054	0.125	−50	Δ% OF R/O	−0.8	−4.8	+0.8	+3.9	−1.27	+0.01
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 7.8	STORM U/S F +0.016 W +0.096 SP −0.016 SU −0.078
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.17	2.20	1.95	0.27		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
T055	0.375	+50	Δ% OF R/O	+0.8	+4.5	−0.8	−3.6	+2.53	−0.01
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 8.1	STORM U/S F +0.016 W +0.090 SP −0.016 SU −0.072
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.18	2.42	1.92	0.25		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D056	0.50	+100	Δ% OF R/O	0.0	+9.09	−1.55	----	----	----
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = ----	STORM U/S F 0.0 W +0.091 SP −0.015 SU ----
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.175	2.52	1.91	----		
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		

SENSITIVITY ANALYSIS OF SIAC (0.42)

SNOW WATERSHED 277 SQ. KM

TABLE 6-77

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
122	0.0	−100	Δ% OF R/O	+0.2	−2.2	−17.8	+3.1	+3.33	−0.59
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S F −0.002 W +0.022 SP +0.178 SU −0.031
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.038	0.75	0.045		
			REF (R/F/R/O)	91	--	1.94	25		
123	0.84	+100	Δ% OF R/O	−0.2	+0.4	+18.0	−3.9	−6.67	+0.63
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.8	STORM U/S F −0.002 W +0.004 SP +0.180 SU −0.039
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	1.081	0.041		
			REF (R/F/R/O)	91	--	1.94	25		

TABLE 6-78

SENSITIVITY ANALYSIS OF SIAC (0.60)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	−100	Δ% OF R/O	+0.1	−8.0	+6.1	+2.2	+7.30	−0.89
			Δ% OF MONTHLY R/O	OCT 0.0	JAN −4.4	APR −1.50	AUG +3.10	REF = 644 SIM = 691	STORM U/S F −0.001 W +0.080 SP −0.061 SU −0.022
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	0.90	0.52	0.07		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW46	0.30	−50	Δ% OF R/O	+0.1	−4.4	+3.3	+1.2	+3.57	−0.49
			Δ% OF MONTHLY R/O	OCT 0.0	JAN −2.42	APR −0.85	AUG +1.55	REF = 644 SIM = 667	STORM U/S F −0.002 W +0.088 SP −0.066 SU −0.024
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	0.94	0.50	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW45	0.90	+50	Δ% OF R/O	+0.1	+4.7	−3.5	−1.3	−3.26	+0.56
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +2.67	APR +0.85	AUG −1.55	REF = 644 SIM = 623	STORM U/S F +0.002 W +0.094 SP −0.070 SU −0.026
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	1.03	0.47	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-79

SENSITIVITY ANALYSIS OF SIAC (0.60)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	−100	Δ% OF R/O	0.0	−14.5	+5.7	+3.1	+2.94	−0.77
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 35	STORM U/S F 0.0 W +0.145 SP −0.057 SU −0.031
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.38	0.79	0.06		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW46	0.30	−50	Δ% OF R/O	0.0	−8.5	+3.5	+1.8	+2.94	−0.44
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 35	STORM U/S F 0.0 W +0.170 SP −0.070 SU −0.036
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.47	0.78	0.06		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW45	0.90	+50	Δ% OF R/O	0.0	+8.7	−4.0	−2.2	−5.88	+0.56
			STORM R/F	2.16	1.91	3.49	2.79	REF =34 SIM = 32	STORM U/S F 0.0 W +0.174 SP −0.080 SU −0.044
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.75	0.72	0.06		
6-106			REF (R/F/R/O)	48	1.18	4.65	46.5		

TABLE 6-80

SENSITIVITY ANALYSIS OF SIAC (0.60)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	−100	Δ% OF R/O	+0.6	−11.3	+4.3	+3.7	+4.35	−0.58
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 24	STORM U/S F −0.006 W +0.113 SP −0.043 SU −0.037
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.10	1.92	0.54	0.12		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW46	0.30	−50	Δ% OF R/O	+0.3	−6.3	+2.5	+1.8	0.0	−0.34
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S F −0.006 W +0.126 SP −0.050 WU −0.036
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.10	2.03	0.53	0.12		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW45	0.90	+50	Δ% OF R/O	−0.3	+6.3	−3.1	−1.8	0.0	+0.38
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S F −0.006 W +0.126 SP −0.062 SU −0.036
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.09	2.31	0.50	0.12		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		

TABLE 6-81

SENSITIVITY ANALYSIS OF SIAC (0.60)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	−100	Δ% OF R/O	0.0	−10.0	+6.0	+0.9	+25.0	−0.70
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S F 0.0 W +0.100 SP −0.060 SU −0.009
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	1.72	0.98	0.09		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW46	0.30	−50	Δ% OF R/O	0.0	−4.8	+3.4	+0.5	+25.0	−0.35
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S F 0.0 W +0.096 SP −0.068 SU −0.010
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	1.82	0.95	0.09		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW45	0.90	+50	Δ% OF R/O	0.0	+4.7	−4.2	−0.7	0.0	+0.48
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S F 0.0 W +0.094 SP −0.084 SU −0.014
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	2.00	0.88	0.09		
6-107			REF (R/F/R/O)	30	1.06	1.97	25.8		

TABLE 6-82

SENSITIVITY ANALYSIS OF SIAC (0.60)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	-100	Δ% OF R/O	+0.1	-12.2	+4.2	+18.2	+5.0	-1.09
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 42	STORM U/S F -0.001 W +0.122 SP -0.042 SU -0.182
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.37	0.64	0.15		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW46	0.30	- 50	Δ% OF R/O	0.0	-6.2	+2.4	+8.1	+2.5	-0.61
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 41	STORM U/S F 0.0 W +0.124 SP -0.048 SU -0.162
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.46	0.62	0.14		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW45	0.90	+ 50	Δ% OF R/O	+0.2	+5.8	-2.5	-6.3	-2.5	+0.63
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 39	STORM U/S F +0.004 W +0.116 SP -0.050 SU -0.126
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.65	0.59	0.12		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		

TABLE 6-83

SENSITIVITY ANALYSIS OF SIAC (0.60)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW44	0.001	-100	Δ% OF R/O	0.0	-7.1	+5.2	+1.8	+11.11	-0.97
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S F 0.0 W +0.071 SP -0.052 SU -0.018
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.71	0.62	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW46	0.30	- 50	Δ% OF R/O	0.0	-3.4	+2.8	+1.0	+11.11	-0.53
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S F 0.0 W +0.068 SP -0.056 SU -0.020
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.74	0.60	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW45	0.90	+ 50	Δ% OF R/O	0.0	+3.3	-2.8	-1.0	0.0	+0.59
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 9	STORM U/S F 0.0 W +0.066 SP -0.056 SU -0.020
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.79	0.57	0.03		
6-108			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

TABLE 6-84

SENSITIVITY ANALYSIS OF SIAC –100% PERTURBATION (0.25 – 0.60)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID D053			Δ% OF R/O	-2.86	-9.52	+1.65	–	–	–
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.029 W +0.095
			PERT. R/O	0.17	2.09	1.97	–	SIM = –	SP -0.016
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU –
RUN ID 122			Δ% OF R/O	+0.2	-2.2	-17.8	+3.1	+3.33	-0.59
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.002 W +0.022
			PERT. R/O	0.033	0.038	0.75	0.045	SIM = 3.1	SP +0.178
			REF (R/F/R/O)	91	—	1.94	25		SU -0.031
RUN ID RW44			Δ% OF R/O	+0.1	-8.0	+6.1	+2.2	+7.30	-0.89
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -4.4	APR -1.50	AUG +3.10	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.001 W +0.080
			PERT. R/O	0.10	0.90	0.52	0.07	SIM = 691	SP -0.061
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.022
RUN ID RW44			Δ% OF R/O	0.0	-14.5	+5.7	+3.1	+2.94	-0.77
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F 0.0 W +0.145
			PERT. R/O	0.04	1.38	0.79	0.06	SIM = 35	SP -0.057
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.031
RUN ID RW44			Δ% OF R/O	+0.6	-11.3	+4.3	+3.7	+4.35	-0.58
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.006 W +0.113
			PERT. R/O	0.10	1.92	0.54	0.12	SIM = 24	SP -0.043
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.037
RUN ID RW44			Δ% OF R/O	0.0	-10.0	+6.0	+0.9	+25.0	-0.70
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W +0.100
			PERT. R/O	0.04	1.72	0.98	0.09	SIM = 5	SP -0.060
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.009
RUN ID RW44			Δ% OF R/O	+0.1	-12.2	+4.2	+18.2	+5.0	-1.09
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.001 W +0.122
			PERT. R/O	0.03	1.37	0.64	0.15	SIM = 42	SP -0.042
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.182
RUN ID RW44			Δ% OF R/O	0.0	-7.1	+5.2	+1.8	+11.11	-0.97
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F 0.0 W +0.071
			PERT. R/O	0.15	0.71	0.62	0.03	SIM = 10	SP -0.052
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.018

TABLE 6-85

SENSITIVITY ANALYSIS OF SIAC -50% PERTURBATION (0.25 – 0.60)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID S054			Δ% OF R/O	-0.8	-4.8	+0.8	+3.9	-1.27	+0.01
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.016 W +0.096
			PERT. R/O	0.17	2.20	1.95	0.27	SIM = 7.8	SP -0.016
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.078
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW46			Δ% OF R/O	+0.1	-4.4	+3.3	+1.2	+3.57	-0.49
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -2.42	APR -0.85	AUG +1.55	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.002 W +0.088
			PERT. R/O	0.10	0.94	0.50	0.06	SIM = 667	SP -0.066
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.024
RUN ID RW46			Δ% OF R/O	0.0	-8.5	+3.5	+1.8	+2.94	-0.44
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F 0.0 W +0.170
			PERT. R/O	0.04	1.47	0.78	0.06	SIM = 35	SP -0.070
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.036
RUN ID RW46			Δ% OF R/O	+0.3	-6.3	+2.5	+1.8	0.0	-0.34
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.006 W +0.126
			PERT. R/O	0.10	2.03	0.53	0.12	SIM = 23	SP -0.050
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.036
RUN ID RW46			Δ% OF R/O	0.0	-4.8	+3.4	+0.5	+25.0	-0.35
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W +0.096
			PERT. R/O	0.04	1.82	0.95	0.09	SIM = 5	SP -0.068
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.010
RUN ID RW46			Δ% OF R/O	0.0	-6.2	+2.4	+8.1	+2.5	-0.61
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F 0.0 W +0.124
			PERT. R/O	0.03	1.46	0.62	0.14	SIM = 41	SP -0.048
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.162
RUN ID RW46			Δ% OF R/O	0.0	-3.4	+2.8	+1.0	+11.11	-0.53
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F 0.0 W +0.068
			PERT. R/O	0.15	0.74	0.60	0.03	SIM = 10	SP -0.056
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.020

TABLE 6-86

SENSITIVITY ANALYSIS OF SIAC +60% PERTURBATION (0.25 – 0.60)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID T055			Δ% OF R/O	+0.8	+4.5	-0.8	-3.6	+2.53	-0.01
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.016 W +0.090
			PERT. R/O	0.18	2.42	1.92	0.25	SIM = 8.1	SP -0.016
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.072
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW45			Δ% OF R/O	+0.1	+4.7	-3.5	-1.3	-3.26	+0.56
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +2.67	APR +0.85	AUG -1.55	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F +0.002 W +0.094
			PERT. R/O	0.10	1.03	0.47	0.06	SIM = 623	SP -0.070
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.026
RUN ID RW45			Δ% OF R/O	0.0	+8.7	-4.0	-2.2	-5.88	+0.56
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F 0.0 W +0.174
			PERT. R/O	0.04	1.75	0.72	0.06	SIM = 32	SP -0.080
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.044
RUN ID RW45			Δ% OF R/O	-0.3	+6.3	-3.1	-1.8	0.0	+0.38
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.006 W +0.126
			PERT. R/O	0.09	2.31	0.50	0.12	SIM = 23	SP -0.062
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.036
RUN ID RW45			Δ% OF R/O	0.0	+4.7	-4.2	-0.7	0.0	+0.48
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W +0.094
			PERT. R/O	0.04	2.00	0.88	0.09	SIM = 4	SP -0.084
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.014
RUN ID RW45			Δ% OF R/O	+0.2	+5.8	-2.5	-6.3	-2.5	+0.63
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +0.004 W +0.116
			PERT. R/O	0.03	1.65	0.59	0.12	SIM = 39	SP -0.050
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.126
RUN ID RW45			Δ% OF R/O	0.0	+3.3	-2.8	-1.0	0.0	+0.59
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F 0.0 W +0.066
			PERT. R/O	0.15	0.79	0.57	0.03	SIM = 9	SP -0.056
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.020

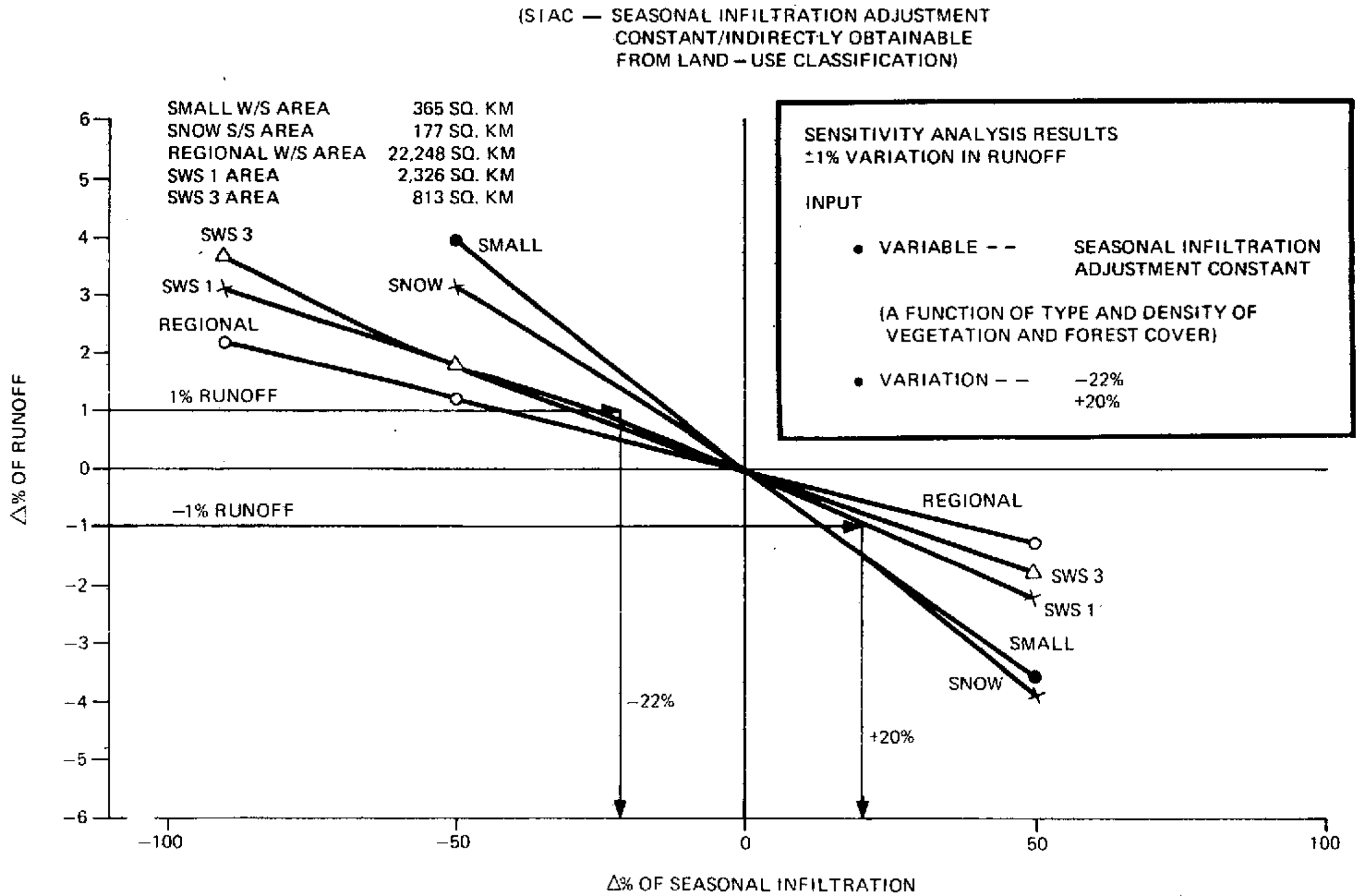


Figure 6-19. Seasonal Infiltration Study, Summer Storms

6.3.9 BMIR, BASIC MAXIMUM INFILTRATION RATE

BMIR is the basic infiltration index used to control the rate of infiltration. Since infiltration rate varies considerably from point to point in a watershed and most runoff will be from points with smaller rates, an average infiltration value is not appropriate for use in watershed modeling. Instead a cumulative frequency distribution of infiltration capacity is used in the model.

The distribution of moisture supply among surface detention, interflow detention and infiltration is assumed to be linear from zero (equalled or exceeded by all points in the watershed) to a maximum value (reached only at a single point in the watershed). Hence, at times when moisture supply is larger, the fraction of new moisture entering overland flow and interflow is larger because the infiltration capacity of larger portions of the watershed is exceeded.

The parameter BMIR would logically relate to the "A" horizon permeability; the permeability of the surface layer of the watershed soil will most often influence the infiltration capacity of the watershed.

The parameter BMIR is important since it determines the basic division between surface runoff and infiltration to interflow, soil water, and ground water. As such it is influential in all seasons.

The average unit sensitivity is 0.20 during the winter seasons and 0.13 during the summer seasons. Results appear in Tables 6-87 through 6-96 and Figure 6-20.

The parameter can be inferred from land-use classification after a relationship of soil associations, type and density of vegetation and forest cover is related to BMIR. At present, the parameter is quantified by calibration and manual adjustment.

TABLE 6-87

SENSITIVITY ANALYSIS OF BMIR (7.0)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D058	0.001	−100	Δ% OF R/O	+1420.0	+36.6	+14.4	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = ———	STORM U/S F – 14.200 W – 0.366 SP – 0.144 SU ———
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	2.66	3.16	2.22	———		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S059	3.5	−50	Δ% OF R/O	+129.9	+13.4	+4.1	+32.8	−27.85	+1.71
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 5.7	STORM U/S F – 2.598 W – 0.268 SP – 0.082 SU – 0.656
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.40	2.62	2.02	0.34		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
S060	10.5	+50	Δ% OF R/O	−26.5	−9.0	−3.3	−12.0	+13.92	– 0.65
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 9.0	STORM U/S F – 0.530 W – 0.180 SP – 0.066 SU – 0.240
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.13	2.11	1.87	0.22		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D061	14.0	+100	Δ% OF R/O	−37.14	−15.58	−6.19	———	———	———
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = –	STORM U/S F – 0.371 W – 0.156 SP – 0.070 SU ———
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.11	1.95	1.82	———		
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		

TABLE 6-88

SENSITIVITY ANALYSIS OF BMIR (20.0)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/67 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
62	10.0	−50	Δ% OF R/O	+0.5	+5.8	+27.7	−6.6	−16.67	+1.11
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 2.5	F − 0.010
			PERT. R/O (IN.)	0.033	0.042	1.170	0.040		W − 0.112
			REF (R/F/R/O)	91	—	1.94	25		SP − 0.554 SU + 0.132
63	16.0	−20	Δ% OF R/O	+0.2	+1.3	+8.5	−1.8	−6.67	+0.29
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 2.8	F − 0.010
			PERT. R/O (IN.)	0.033	0.040	0.994	0.042		W − 0.065
			REF (R/F/R/O)	91	—	1.94	25		SP − 0.425 SU + 0.090
64	24.0	+20	Δ% OF R/O	0.0	−1.2	−6.2	+1.2	0.0	−0.20
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F 0.0
			PERT. R/O (IN.)	0.033	0.038	0.859	0.044		W −0.060
			REF (R/F/R/O)	91	—	1.94	25		SP −0.310 SU +0.060
65	30.0	+50	Δ% OF R/O	−0.5	−2.9	−12.6	+2.5	+3.3	− .37
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.1	F − 0.010
			PERT. R/O (IN.)	0.032	0.038	0.800	0.044		W − 0.058
			REF (R/F/R/O)	91	—	1.94	25		SP − 0.252 SU − 0.050

6-115

TABLE 6-89

SENSITIVITY ANALYSIS OF BMIR (12.0)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	6/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW51	6.0	−50	Δ% OF R/O	+0.2	+9.0	−2.2	−6.6	−8.39	+ 1.79
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +4.71	APR +2.96	AUG −6.98		STORM U'S F − 0.004 W − 0.180 SP + 0.044 SU + 0.132
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644 SIM =	
			PERT. R/O (IN)	0.099	1.068	0.476	0.059		
			REF MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW50	10.8	−10	Δ% OF R/O	+0.1	+1.3	+0.3	−1.0	−1.55	+ 0.26
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +0.74	APR +0.46	AUG −1.16		STORM U/S F − 0.010 W − 0.130 SP − 0.030 SU + 0.100
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644 SIM = 634	
			PERT. R/O (IN)	0.10	0.99	0.49	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW48	13.2	+10	Δ% OF R/O	+0.1	−1.2	−0.3	+0.9	+1.40	−0.21
			Δ% OF MONTHLY R/O	OCT 0.0	JAN −0.69	APR −0.42	AUG +1.16		STORM U/S F + 0.010 W − 0.120 SP − 0.030 SU + 0.090
			REF. R/O (IN)	0.099	0.980	0.487	0.064	REF = 644 SIM = 653	
			PERT. R/O (IN)	0.10	0.97	0.49	0.06		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW49	18.0	+50	Δ% OF R/O	+0.4	−4.9	+0.5	+3.5	+6.06	− 0.76
			Δ% OF MONTHLY R/O	OCT 0.0	JAN −2.70	APR −1.69	AUG +3.88		STORM U/S F + 0.008 W − 0.098 SP + 0.010 SU + 0.070
			REF. R/O (IN)	0.093	0.980	0.487	0.064	REF = 644 SIM = 683	
			PERT. R/O (IN)	0.099	0.932	0.490	0.066		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-90

SENSITIVITY ANALYSIS OF BMIR (10.0)

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

SUBWATERSHED NO. 1 2,326 SQ. KM

RUN ID	PARAM VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW51	5.0	−50	Δ% OF R/O	+0.9	+17.2	+1.5	−10.1	−20.59	+ 1.30
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 27	STORM U/S F − 0.018 W − 0.344 SP − 0.030 SU + 0.202
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.045	1.887	0.761	0.053		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW50	9.0		Δ% OF R/O	−0.5	+2.8	+0.2	−1.5	− 2.94	+0.19
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 33	STORM U/S F + 0.050 W − 0.280 SP − 0.020 SU + 0.150
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.65	0.75	0.06		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW48	11.0	+10	Δ% OF R/O	−0.4	−2.6	−0.1	+1.3	+2.94	− 0.14
			STORM R/F	2.16	1.91	3.49	2.79	REF =34 SIM =	STORM U/S F − 0.040 W − 0.260 SP − 0.010 SU + 0.130
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.57	0.75	0.06		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW49	15.0	+50	Δ% OF R/O	+1.9	−10.1	−0.6	+5.5	+8.82	− 0.46
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 37	STORM U/S F + 0.038 W − 0.202 SP − 0.012 SU + 0.110
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0456	1.4473	0.7445	0.0619		
6-117			REF (R/F/R/O)	48	1.18	4.65	46.5		

SENSITIVITY ANALYSIS OF BMIR (10.0)

TABLE 6-91

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW51	5.0	−50	Δ% OF R/O	+4.6	+9.6	+8.4	−7.2	−17.39	+ 1.60
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 19	STORM U/S F − 0.092 W − 0.192 SP − 0.168 SU+ 0.144
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.099	2.377	0.565	0.109		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW50	9.0	−10	Δ% OF R/O	+0.3	+1.5	+1.0	−1.1	−4.35	+ 0.22
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 22	STORM U/S F − 0.030 W − 0.150 SP − 0.100 WU+ 0.110
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.10	2.20	0.53	0.12		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW48	11.0	+10	Δ% OF R/O	−0.3	−1.5	−0.8	+1.0	+4.35	− 0.21
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 24	STORM U/S F − 0.030 W − 0.150 SP − 0.080 SU + 0.100
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.09	2.14	0.52	0.12		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
RW49	15.0	+50	Δ% OF R/O	−0.6	−6.0	−2.7	+4.2	+13.04	− 0.73
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 26	STORM U/S F − 0.012 W − 0.120 SP − 0.054 SU+ 0.084
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.0943	2.0398	0.5069	0.1222		
6-118			REF (R/F/R/O)	26.4	1.43	3.26	18.9		

TABLE 6-92

SENSITIVITY ANALYSIS OF BMIR (10.0)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW51	5.0	−50	Δ% OF R/O	−0.8	+9.7	+1.9	−5.2	−25.0	+ 1.67
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 3	STORM U/S F + 0.016 W − 0.194 SP − 0.038 SU + 0.104
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.036	2.092	0.939	0.082		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW50	9.0	−10	Δ% OF R/O	+0.1	+1.5	+0.4	−0.7	0.0	+ 0.18
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S F − 0.010 W − 0.150 SP − 0.040 SU + 0.070
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	1.93	0.92	0.09		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW48	11.0	+10	Δ% OF R/O	0.0	−1.3	−0.3	+0.6	+25.0	− 0.14
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S F 0.0 W − 0.130 SP − 0.030 SU + 0.060
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.04	1.88	0.92	0.09		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
RW49	15.0	+50	Δ% OF R/O	+0.6	−6.4	−1.9	+2.4	+25.0	− 0.57
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S F + 0.012 W − 0.128 SP − 0.038 SU + 0.048
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.0361	1.7844	0.9037	0.0882		
6-119			REF (R/F/R/O)	30	1.06	1.97	25.8		

TABLE 6-93

SENSITIVITY ANALYSIS OF BMIR (12.0)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW51	6.0	−50	Δ% OF R/O	+2.4	+11.4	+13.3	+6.0	−15.0	+ 2.02
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 34	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F − 0.048 W − 0.228
			PERT. R/O (IN.)	0.030	1.735	0.691	0.135		SP − 0.266
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU − 0.120
RW50	10.8	−10	Δ% OF R/O	+0.5	+1.7	+1.8	+0.2	−2.50	+ 0.28
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 39	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F − 0.050 W − 0.170
			PERT. R/O (IN.)	0.03	1.58	0.62	0.13		SP − 0.180
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU − 0.020
RW48	13.2	+10	Δ% OF R/O	+0.3	−1.9	−1.6	0.0	+2.50	− 0.29
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 41	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F + 0.030 W − 0.190
			PERT. R/O (IN.)	0.03	1.53	0.60	0.13		SP − 0.160
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU 0.0
RW49	18.0	+50	Δ% OF R/O	+1.5	−7.4	−4.7	+0.1	+7.5	− 0.91
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 43	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F + 0.030 W − 0.148
			PERT. R/O (IN.)	0.0299	1.4412	0.581	0.1271		SP − 0.094
6-120			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU + 0.002

TABLE 6-94

SENSITIVITY ANALYSIS OF BMIR (8.0)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW51	4.0	−50	Δ% OF R/O	−0.4	+4.0	+1.3	−4.4	−11.11	+ 1.65
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S F + 0.008 W − 0.080 SP− 0.026 SU+ 0.088
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.150	0.800	0.595	0.030		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW50	7.2	−10	Δ% OF R/O	−0.1	+0.8	+0.1	−0.6	0.0	+ 0.26
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 9	STORM U/S F + 0.010 W − 0.016 SP− 0.010 SU + 0.060
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.78	0.59	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW48	8.8	+10	Δ% OF R/O	0.0	−0.8	−0.2	+0.6	0.0	− 0.21
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 9	STORM U/S F 0.0 W − 0.080 SP − 0.020 SU+ 0.060
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.76	0.59	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW49	12.0	+50	Δ% OF R/O	+0.3	−3.6	−0.7	+2.2	+11.11	− 0.82
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 10	STORM U/S F + 0.006 W − 0.072 SP− 0.014 SU+ 0.044
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.1506	0.7414	0.5835	0.0319		
6-121			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

TABLE 6-96

SENSITIVITY ANALYSIS OF BMIR -50% PERTURBATION (7.0 - 20.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O	+129.9	+13.4	+4.1	+32.8	-27.85	1.71
S059			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -2.598 W -0.268
			PERT. R/O	0.40	2.62	2.02	0.34	SIM = 5.7	SP -0.082
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.656
RUN ID			Δ% OF R/O	+0.5	+5.6	+27.7	-6.6	-16.67	+1.11
62			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.010 W -0.112
			PERT. R/O	0.033	0.042	1.170	0.040	SIM = 2.5	SP -0.554
			REF (R/F/R/O)	91	—	1.94	25		SU +0.132
RUN ID 51			Δ% OF R/O	+0.2	+9.0	-2.2	-6.6	-8.39	+1.79
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +4.71	APR +2.96	AUG -6.98	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.004 W -0.180
			PERT. R/O	0.099	1.068	0.476	0.059	SIM = 590	SP +0.044
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.132
RUN ID 51			Δ% OF R/O	+0.9	+17.2	+1.5	-10.1	-20.59	+1.30
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.018 W -0.344
			PERT. R/O	0.045	1.887	0.761	0.053	SIM = 27	SP -0.030
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.202
RUN ID 51			Δ% OF R/O	+4.6	+9.6	+8.4	-7.2	-17.39	+1.60
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.092 W -0.192
			PERT. R/O	0.099	2.377	0.565	0.109	SIM = 19	SP -0.168
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.144
RUN ID 51			Δ% OF R/O	-0.8	+9.7	+1.9	-5.2	-25.0	+1.67
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F +0.016 W -0.194
			PERT. R/O	0.036	2.092	0.939	0.082	SIM = 3	SP -0.038
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.104
RUN ID 51			Δ% OF R/O	+2.4	+11.4	+13.3	+6.0	-15.0	+2.02
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.048 W -0.228
			PERT. R/O	0.030	1.735	0.691	0.135	SIM = 34	SP -0.266
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.120
RUN ID 51			Δ% OF R/O	-0.4	+4.0	+1.3	-4.4	-11.11	+1.65
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F +0.008 W -0.080
			PERT. R/O	0.150	0.800	0.595	0.030	SIM = 8	SP -0.026
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.088

TABLE 6-96

SENSITIVITY ANALYSIS OF BMIR +50% PERTURBATION (7.0 - 20.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O	-26.5	-9.0	-3.3	-12.0	+13.92	-0.65
SO 60			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.530 W -0.180
			PERT. R/O	0.13	2.11	1.87	0.22	SIM = 9.0	SP -0.066
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.240
RUN ID			Δ% OF R/O	-0.5	-2.9	-12.6	+2.5	+3.3	-0.37
65			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F -0.010 W -0.058
			PERT. R/O	0.032	0.038	0.800	0.044	SIM = 3.1	SP -0.252
			REF (R/F/R/O)	91	—	1.94	25		SU -0.050
RUN ID RW 49			Δ% OF R/O	+0.4	-4.9	+0.5	+3.5	+6.06	-0.76
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -2.70	APR -1.69	AUG +3.88	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F +0.008 W -0.098
			PERT. R/O	0.099	0.932	0.490	0.066	SIM = 683	SP +0.010
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.070
RUN ID RW 49			Δ% OF R/O	+1.9	-10.1	-0.6	+5.5	+8.82	-0.46
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F +0.038 W -0.202
			PERT. R/O	0.0456	1.4473	0.7445	0.0619	SIM = 37	SP -0.012
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.110
RUN ID RW 49			Δ% OF R/O	-0.6	-6.0	-2.7	+4.2	+13.04	-0.73
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.012 W -0.120
			PERT. R/O	0.0943	2.0398	0.5069	0.1222	SIM = 26	SP -0.054
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.084
RUN ID RW49			Δ% OF R/O	+0.6	-6.4	-1.9	+2.4	+25.0	-0.57
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F +0.012 W -0.128
			PERT. R/O	0.0361	1.7844	0.9037	0.0882	SIM = 5	SP -0.038
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.048
RUN ID RW 49			Δ% OF R/O	+1.5	-7.4	-4.7	+0.1	+7.5	-0.91
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +0.030 W -0.148
			PERT. R/O	0.0299	1.4412	0.581	0.1271	SIM = 43	SP -0.094
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU +0.002
RUN ID RW 49			Δ% OF R/O	+0.3	-3.6	-0.7	+2.2	+11.11	-0.82
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F +0.006 W -0.072
			PERT. R/O	0.1506	0.7414	0.5835	0.0319	SIM = 10	SP -0.014
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.044

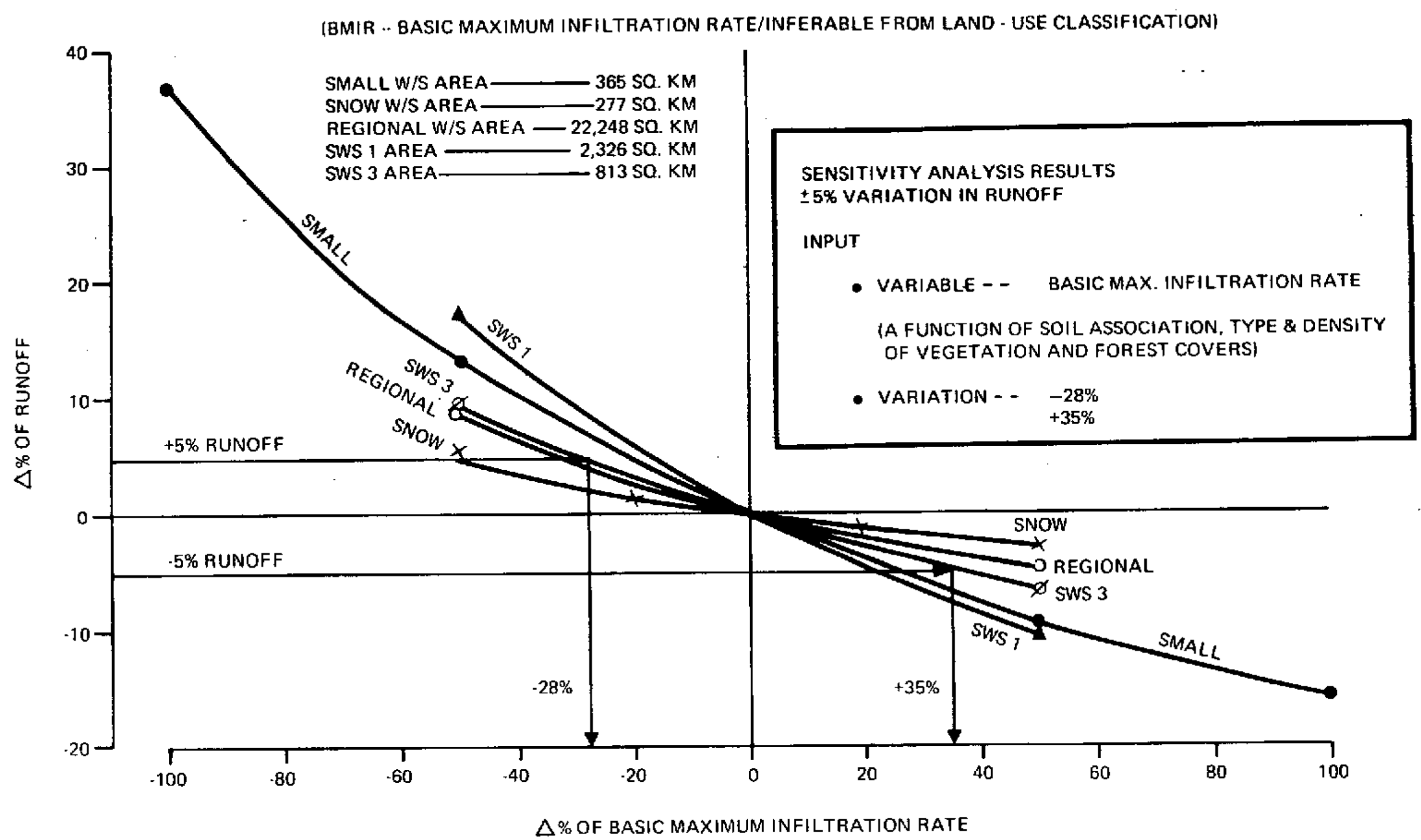


Figure 6-20. Basic Maximum Infiltration Rate Study, Winter Storm

6.3.10 OVERLAND FLOW SURFACE SLOPE

OFSS is the average slope in meters per meter of the overland flow surfaces perpendicular to the receiving channels and may be estimated by averaging a series of measurements made for a randomly selected group of points on a topographic map of the watershed.

This parameter is used to calculate the rate of discharge from overland flow. This rate is based on the Chezy-Manning equation

$$q = \frac{1.486}{n} (y^{5/3})(s^{1/2})$$

where q is discharge in cfs/ft, y is the depth in feet at the lower edge of the flow plane, and s is the slope of the surface in ft/ft. The outflow depth (y) is expressed empirically in terms of surface detention in order that continuous overland flow can be calculated.

Sensitivity analysis results indicate that the small watershed has a unit sensitivity of 0.21 for the fall season for a -50% perturbation of OFSS. In all other basins and seasons the unit sensitivity is less. This is due to a combination of factors: (1) overland flow (a concept useful in modeling but not believed by all hydrologists actually to exist) contributes only a portion of streamflow; (2) in the fall, after a dry summer season, infiltration is maximum, and the proportion of streamflow due to overland flow is greater; (3) overland flow rate in the model is proportional to $(OFSS)^{1/2}$, causing the parameter to be more influential, in terms of unit sensitivity, in basins for which the reference value of OFSS is small. In the regional watershed, all the initial values of OFSS were initially very low. They were raised to a reference value of 0.10 for all subwatersheds to provide for wider parameter variations at reasonable percentage variations.

Results are shown in Tables 6-97 through 6-106, and in Figures 6-21 and 6-22.

TABLE 6-97

SENSITIVITY ANALYSIS OF OFSS (0.062)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D067	0.001	-100	Δ% OF R/O	-38.8	-8.0	0.0	—	—	—
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = —	F +0.388
			PERT. R/O (IN)	0.11	2.18	1.94	—		W +0.060
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP 0.0 SU —
T068	0.031	- 50	Δ% OF R/O	-10.5	-0.7	+0.4	-3.9	+3.80	-0.12
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = 8.2	F +0.210
			PERT. R/O (IN)	0.16	2.30	1.95	0.25		W +0.014
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP -0.008 SU +0.078
T069	0.093	+ 50	Δ% OF R/O	+6.2	+0.4	-0.2	+2.2	-1.3	+0.07
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = 7.8	F +0.124
			PERT. R/O (IN)	0.19	2.32	1.93	0.26		W +0.008
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SP -0.004 SU +0.044
D070	0.124	+100	Δ% OF R/O	+10.8	+0.7	-0.4	—	—	—
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	SIM = —	F +0.108
			PERT. R/O (IN)	0.19	2.33	1.93	—		W +0.007
6-126			REF (R/F/R/O)	17.9	3.19	1.47	8.3		SP -0.004 SU —

TABLE 6-98

SENSITIVITY ANALYSIS OF OFSS (0.34)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
20	0.0001	-100	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	––	1.94	25		
22	0.170	- 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	––	1.94	25		
25	0.510	+ 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	––	1.94	25		
27	0.680	+100	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
6-127			REF (R/F/R/O)	91	––	1.94	25		

TABLE 6-99

SENSITIVITY ANALYSIS OF OFSS (0.10 REF.)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW 56	0.001	-100	Δ% OF R/O	-0.10	-0.72	+0.06	+0.63	+0.84	-0.23
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +0.03	APR +0.15	AUG +0.78	REF = 641 SIM = 647	STORM U/S F +C.001 W +0.007 SP -0.001 SU -0.006
			REF. R/O (IN)	0.0988	0.9824	0.4874	0.0634		
			PERT. R/O (IN)	0.0987	0.9753	0.4877	0.0643		
			REF. MONTHLY R/O (IN)	0.177	3.631	2.599	0.257		
RW 60	0.30	+200	Δ% OF R/O	0.0	+0.07	+0.14	-0.31	-0.47	+0.10
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -0.06	APR 0.0	AUG -0.39	REF = 641 SIM = 638	STORM U/S F 0.0 W +0.001 SP +0.0 SU -0.007
			REF. R/O (IN)	0.0988	0.9824	0.4874	0.0639		
			PERT. R/O (IN)	0.988	0.9831	0.4881	0.0637		
			REF. MONTHLY R/O (IN)	0.177	3.631	2.599	0.257		

TABLE 6-100

SENSITIVITY ANALYSIS OF OFSS (0.10 REF.)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW 56	0.001	-100	Δ% OF R/O	0.0	-2.22	+0.09	+0.51	0.0	-0.10
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 34	STORM U/S F 0.0 W +0.022 SP -0.001 SU -0.005
			REF. R/O (IN.)	0.0447	1.6242	0.7496	0.0585		
			PERT. R/O (IN.)	0.0447	1.5881	0.7503	0.0588		
			REF (R/F/R/O)	48.32	1.18	4.66	47.69		
RW 60	0.30	+200	Δ% OF R/O	+0.22	+0.50	+0.20	-0.17	-2.94	+0.05
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 33	STORM U/S F +0.001 W +0.002 SP +0.001 SU -0.001
			REF. R/O (IN.)	0.0447	1.6242	0.7496	0.0585		
			PERT. R/O (IN.)	0.0448	1.6323	0.7511	0.0584		
			REF (R/F/R/O)	48.32	1.18	4.66	47.69		

TABLE 6-101

SENSITIVITY ANALYSIS OF

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW 56	0.001	-100	Δ% OF R/O	-0.21	+0.46	+0.31	+0.26	0.0	-0.08
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 23	STORM U/S F +0.002 W -0.005 SP -0.003 SU -0.003
			REF. R/O (IN.)	0.0949	2.1655	0.5205	0.1171		
			PERT. R/O (IN.)	0.0947	2.1754	0.5221	0.1174		
			REF (R/F/R/O)	26.45	1.44	3.27	18.87		
RW 60	0.30	+200	Δ% OF R/O	+0.21	-0.18	-0.13	-0.17		+0.05
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM =	STORM U/S F +0.001 W -0.001 SP -0.0 WU -0.001
			REF. R/O (IN.)	0.0949	2.1655	0.5205	0.1171		
			PERT. R/O (IN.)	0.0951	2.1617	0.5198	0.1169		
			REF (R/F/R/O)	26.45	1.44	3.27	18.87		

TABLE 6-102

SENSITIVITY ANALYSIS OF OFSS (0.10 REF.)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
			Δ% OF R/O	0.0	-0.89	-0.98	+0.12	+25.0	-0.04
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW56	0.001	-100	REF. R/O (IN.)	0.0358	1.9169	0.9269	0.0860	REF =4 SIM = 5	F 0.0
			PERT. R/O (IN.)	0.0358	1.8999	0.9178	0.0861		W +0.009
			REF (R/F/R/O)	30.17	1.06	1.96	25.81		SP +0.010 SU -0.001
			Δ% OF R/O	0.0	+0.52	+0.61	0.0	0.0	+0.03
			STORM R/F	1.08	2.04	1.82	2.22		STORM U/S
RW60	0.30	+200	REF. R/O (IN.)	0.0358	1.9169	0.9269	0.0860	REF =4 SIM = 4	F 0.0
			PERT. R/O (IN.)	0.0358	1.9269	0.9326	0.0860		W +0.003
			REF (R/F/R/O)	30.17	1.06	1.96	25.81		SP +0.003 SU 0.0

TABLE 6-103

SENSITIVITY ANALYSIS OF OFSS (0.10 REF.)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
			Δ% OF R/O	0.0	-0.40	+0.18	-0.08	0.0	-0.06
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
RW 56	0.001	-100	REF. R/O (IN.)	0.0294	1.5612	0.6088	0.1270	REF = 40 SIM = 40	F 0.0
			PERT. R/O (IN.)	0.0294	1.5550	0.6099	0.1269		W +0.004
			REF (R/F/R/O)	53.74	1.77	3.15	23.23		SP -0.002 SU -0.001
			Δ% OF R/O	0.0	+0.31	-0.05	+0.08	0.0	+0.04
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
RW 60	0.30	+200	REF. R/O (IN.)	0.0294	1.5612	0.6088	0.1270	REF = 40 SIM = 40	F 0.0
			PERT. R/O (IN.)	0.0294	1.5660	0.6085	0.1271		W +0.001
			REF (R/F/R/O)	53.74	1.77	3.15	23.23		SP 0.0 SU 0.0

TABLE 6-103A

SENSITIVITY ANALYSIS OF OFSS (0.10 REF.)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
			Δ% OF R/O	0.0	-2.12	-4.84	+0.96	0.0	-0.06
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
RW 56	0.001	-100	REF. R/O (IN.)	0.1502	0.7786	0.6033	0.0311	REF = 9 SIM = 9	F 0.0
			PERT. R/O (IN.)	0.1502	0.7621	0.5741	0.0314		W +0.021
			REF (R/F/R/O)	8.99	1.76	3.17	16.08		SP +0.048 SU +0.001
			Δ% OF R/O	+0.07	+1.44	+2.80	-0.64	0.0	0.0
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
RW 60	0.30	+200	REF. R/O (IN.)	0.1502	0.7786	0.6033	0.0311	REF = 9 SIM = 9	F 0.0
			PERT. R/O (IN.)	0.1503	0.7898	0.6202	0.0309		W +0.028
			REF (R/F/R/O)	8.99	1.76	3.17	16.08		SP +0.056 SU -0.003

TABLE 6-104

SENSITIVITY ANALYSIS OF OFSS -100% PERTURBATION

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID DO 67			Δ% OF R/O	-38.8	-6.0	0.0	– –	– –	– –
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.388 W +0.060
(0.062 REF)			PERT. R/O	0.11	2.18	1.94	– –	SIM = – –	SP 0.0
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU – –
RUN ID 20			Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW (0.34 REF)	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F 0.0 W 0.0
			PERT. R/O	0.033	0.039	0.916	0.043	SIM = 3.0	SP 0.0
			REF (R/F/R/O)	91	—	1.94	25		SU 0.0
RUN ID RW 56			Δ% OF R/O	-0.10	-0.72	+0.06	+0.63	+0.94	-0.23
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +0.03	APR +0.15	AUG +0.78	9/15/68	STORM U/S
REGIONAL (0.10 REF)	22,248	41	REF. R/O	0.0988	0.9824	0.4874	0.0639	REF = 641	F +0.001 W +0.007
			PERT. R/O	0.0987	0.9753	0.4877	0.0643	SIM = 647	SP -0.001
			REF. MONTHLY R/O	0.177	3.631	2.599	0.257		SU -0.006
RUN ID RW 56			Δ% OF R/O	0.0	-2.22	+0.09	+0.51	0.0	0.0
SUB-			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
WATERSHED NO.	2,326	50	REF. R/O	0.0447	1.6242	0.7496	0.0585	REF = 34	F 0.0 W +0.022
1 (0.10 REF)			PERT. R/O	0.0447	1.5881	0.7503	0.0588	SIM = 34	SP -0.001
			REF (R/F/R/O)	48.32	1.18	4.66	47.69		SU -0.005
RUN ID RW 56			Δ% OF R/O	-0.21	+0.46	+0.31	+0.26	0.0	-0.08
SUB-			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
WATERSHED NO.	813	50	REF. R/O	0.0949	2.1655	0.5205	0.1171	REF = 23	F +0.002 W -0.005
3 (0.10 REF)			PERT. R/O	0.0947	2.1754	0.5221	0.1174	SIM = 23	SP -0.003
			REF (R/F/R/O)	26.45	1.44	3.27	18.87		SU -0.003
RUN ID RW 56			Δ% OF R/O	0.0	-0.89	-0.98	+0.12	+25.0	-0.04
SUB-			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
WATERSHED NO.	1,064	37	REF. R/O	0.0358	1.9169	0.9269	0.0860	REF = 4	F 0.0 W +0.009
5 (0.10 REF)			PERT. R/O	0.0358	1.8999	0.9178	0.0861	SIM = 5	SP +0.010
			REF (R/F/R/O)	30.17	1.06	1.96	25.81		SU -0.001
RUN ID RW 56			Δ% OF R/O	0.0	-0.40	+0.18	-0.08	0.0	–0.06
SUB-			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
WATERSHED NO.	1,111	40	REF. R/O	0.0294	1.5612	0.6088	0.1270	REF = 40	F 0.0 W 0.004
7 (0.10 REF)			PERT. R/O	0.0294	1.5550	0.6099	0.1269	SIM = 40	SP -0.002
			REF (R/F/R/O)	53.74	1.77	3.15	23.23		SU -0.001
RUN ID RW 56			Δ% OF R/O	0.0	-2.12	-4.84	+0.96	0.0 -0.06	
SUB-			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
WATERSHED NO.	2,551	30	REF. R/O	0.1502	0.7786	0.6033	0.0311	REF = 9	F 0.0 W +0.021
11 (0.10 REF)			PERT. R/O	0.1502	0.7621	0.5741	0.0314	SIM = 9	SP +0.048
			REF (R/F/R/O)	8.99	1.76	3.17	16.08		SU +0.001

TABLE 6-105

SENSITIVITY ANALYSIS OF OFSS +100% PERTURBATION SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID			Δ% OF R/O	+10.8	+0.7	-0.4	– –	– –	– –
DO 70			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL (0.062 REF)	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +0.108 W +0.007
			PERT. R/O	0.19	2.33	1.93	– –	SIM = – –	SP -0.004
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU – –
RUN ID			Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
27			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW (0.34 REF)	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F 0.0 W 0.0
			PERT. R/O	0.033	0.039	0.916	0.043	SIM = 3.0	SP 0.0
			REF (R/F/R/O)	91	—	1.94	25		SU 0.0
RUN ID			Δ% OF R/O						
			Δ% OF MONTHLY R/O	OCT	JAN	APR	AUG	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF. MONTHLY R/O						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O					REF =	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)						SU

TABLE 6-106

SENSITIVITY ANALYSIS OF SMALL, SNOW & REGIONAL WATERSHEDS

OFSS +200% PERTURBATION

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O					REF =	F
			PERT. R/O					SIM =	W SP
			REF (R/F/R/O)						SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O					REF =	F
			PERT. R/O					SIM =	W SP
			REF (R/F/R/O)		—				SU
RUN ID			Δ% OF R/O	0.0	+0.07	+0.14	-0.31	-0.47	+0.10
RW 60			Δ% OF MONTHLY R/O	OCT 0.0	JAN -0.06	APR 0.0	AUG -0.39	9/15/68	STORM U/S
REGIONAL (0.10 REF)	22,248	41	REF. R/O	0.0988	0.9824	0.4874	0.0639	REF = 641	F 0.0
			PERT. R/O	0.0988	0.9831	0.4881	0.0637	SIM = 638	W +0.001 SP 0.0
			REF. MONTHLY R/O	0.177	3.631	2.599	0.257		SU -0.007
RUN ID			Δ% OF R/O	+0.22	+0.50	+0.20	-0.17	-2.94	+0.05
RW 60			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.0447	1.6242	0.7496	0.0585	REF = 34	F +0.001
			PERT. R/O	0.0448	1.6323	0.7511	0.0584	SIM = 33	W +0.002 SP +0.001
(0.10 REF)			REF (R/F/R/O)	48.32	1.18	4.66	47.69		SU -0.001
RUN ID			Δ% OF R/O	+0.21	-0.18	-0.13	-0.17		+0.05
RW 60			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.0949	2.1655	0.5205	0.1171	REF = 23	F +0.001
			PERT. R/O	0.0951	2.1617	0.5198	0.1169	SIM =	W -0.001 SP -0.0
(0.01 REF)			REF (R/F/R/O)	26.45	1.44	3.27	18.87		SU -0.001
RUN ID			Δ% OF R/O	0.0	+0.52	+0.61	0.0	0.0	+0.03
RW 60			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.0358	1.9169	0.9269	0.0860	REF = 4	F 0.0
(0.10 REF)			PERT. R/O	0.0358	1.9269	0.9326	0.0860	SIM = 4	W +0.003 SP +0.003
			REF (R/F/R/O)	30.17	1.06	1.96	25.81		SU 0.0
RUN ID			Δ% OF R/O	0.0	+0.31	-0.05	+0.08	0.0	+0.04
RW 60			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.0294	1.5612	0.6088	0.1270	REF = 40	F 0.0
(0.10 REF)			PERT. R/O	0.0294	1.5660	0.6085	0.1271	SIM = 40	W +0.001 SP 0.0
			REF (R/F/R/O)	53.74	1.77	3.15	23.23		SU 0.0
RUN ID			Δ% OF R/O	+0.07	+1.44	+2.80	-0.64	0.0	0.0
RW 60			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.1502	0.7786	0.6033	0.0311	REF = 9	F 0.0
(0.10 REF)			PERT. R/O	0.1503	0.7698	0.6202	0.0309	SIM = 9	W +0.028 SP +0.058
			REF (R/F/R/O)						SU -0.003

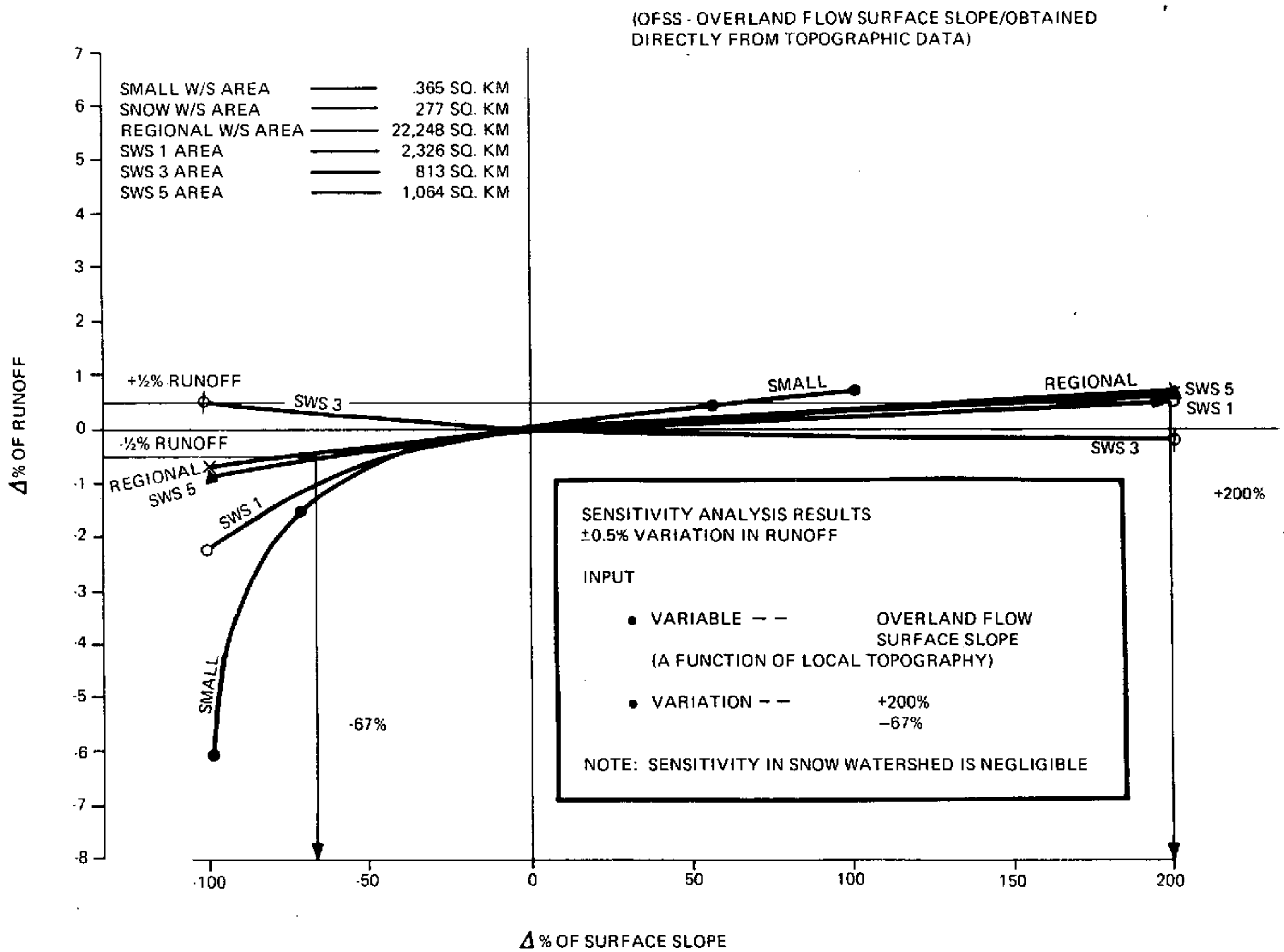


Figure 6-21. Overland Flow Surface Slope Study, Winter Storms

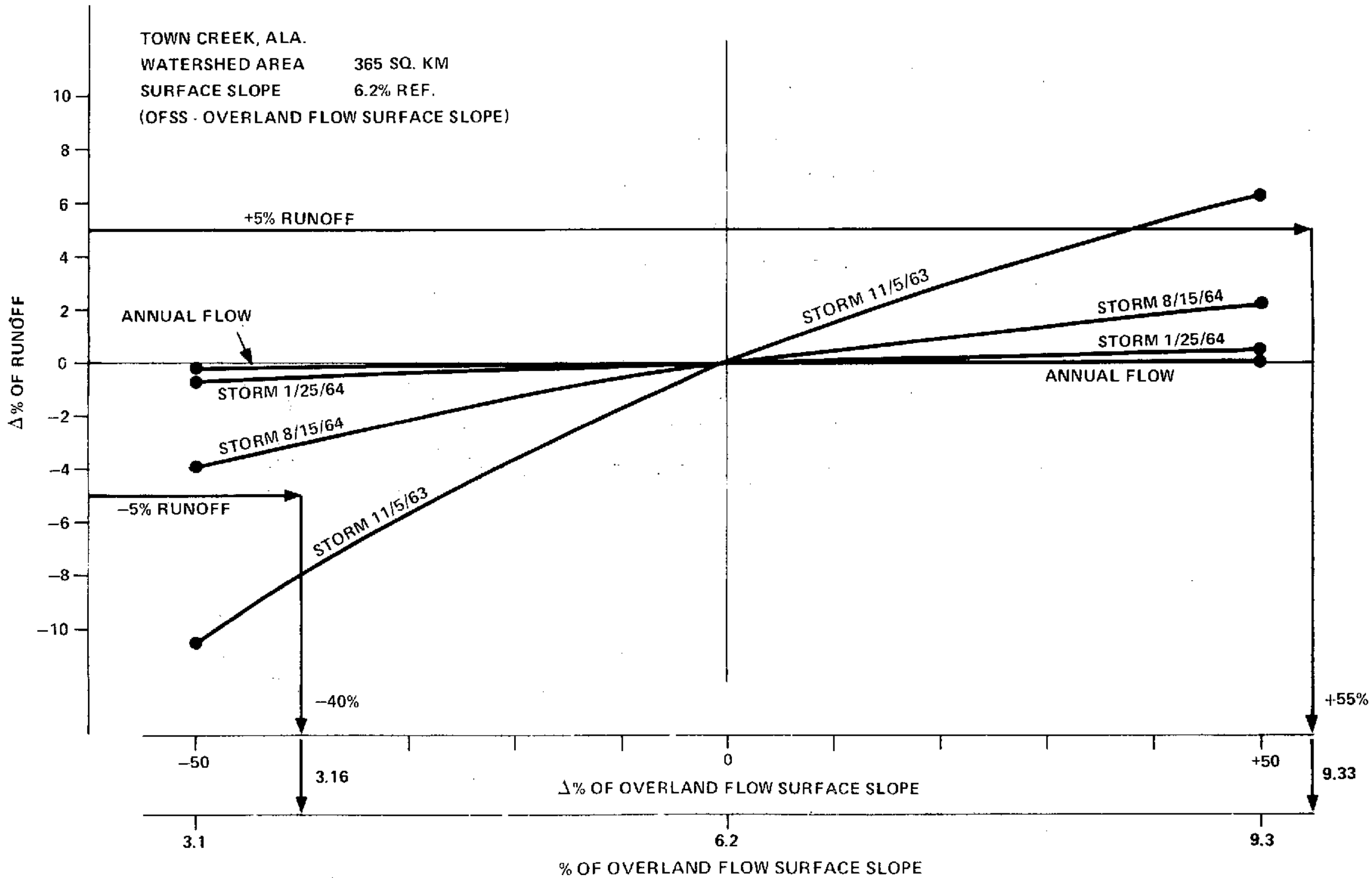


Figure 6-22. Overland Flow Surface Slope Study, Small Watershed

6.3.11 OFSL OVERLAND FLOW SURFACE LENGTH

OFSL is the mean overland flow length in feet. That is, the average distance that surface runoff in the watershed travels before reaching a channel defined in the same manner as was used for OFSS in the preceding section. OFSL may also be estimated by averaging randomly measured distances on topographic maps.

Hydrologically, the larger value of OFSL increases infiltration opportunity and thereby slightly increases the base flow and interflow, and also decreases the direct runoff. The sensitivity analysis results of the small watershed is in agreement. A +50% perturbation in OFSL results in a -0.24 unit sensitivity during the fall season. (Storm runoff has decreased by 12.2%). The response of the low flows to the same perturbation is opposite to that of the fall season.

Results appear in Tables 6-107 through 6-117 and Figures 6-23 and 6-24.

TABLE 6-107

SENSITIVITY ANALYSIS OF OFSL (1550)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D074	0.01	-100	Δ% OF R/O	+91.9	+2.50	-0.6	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = –	STORM U/S F -0.919 W -0.025 SP +0.006 SU –
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.34	2.37	1.93	–		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
T075	775	- 50	Δ% OF R/O	+22.9	+1.3	-0.6	+7.9	-5.1	+0.24
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 7.5	STORM U/S F -0.458 W -0.026 SP +0.012 SU -0.158
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.22	2.34	1.93	0.28		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
T076	2325	+ 50	Δ% OF R/O	-12.2	-0.8	+0.4	-4.7	+3.80	-0.14
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 8.2	STORM U/S F -0.244 W -0.016 SP +0.008 SU -0.094
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.15	2.29	1.95	0.24		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D077	3100	+100	Δ% OF R/O	-19.7	-1.4	+0.7	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = –	STORM U/S F -0.197 W -0.014 SP +0.007 SU –
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.14	2.28	1.95	–		
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		

TABLE 6-108

SENSITIVITY ANALYSIS OF OFSL (1000.)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
28	1.0	-100	Δ% OF R/O	0.0	0.0	+3.2	-0.2	0.0	+0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP -0.032 SU +0.002
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.946	0.043		
			REF (R/F/R/O)	91	--	1.94	25		
30	500.	- 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	--	1.94	25		
31	1500.	+ 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	---	1.94	25		
33	2000.	+100	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
6-137			REF (R/F/R/O)	91	---	1.94	25		

TABLE 6-109

SENSITIVITY ANALYSIS OF OFSL (6914)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW61	691.4	- 90	Δ% OF R/O	+0.2	+0.6	+0.6	-1.3	-2.02	+0.42
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -0.22	APR +0.04	AUG -1.55	REF = 644 SIM = 631	STORM U/S F -0.002 W -0.007 SP -0.001 SU +0.014
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.0989	0.9861	0.490	0.0633		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW63	3457	- 50	Δ% OF R/O	+0.02	+0.24	+0.02	-0.27	–	–
			Δ% OF MONTHLY R/O	OCT +0.01	JAN -0.05	APR -0.05	AUG -0.29	REF = 644 SIM = –	STORM U/S F 0.0 W -0.005 SP 0.0 SU +0.002
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.0988	0.9822	0.4873	0.06395		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW62	10371	+ 50	Δ% OF R/O	-0.01	-0.17	+0.01	+0.12	–	–
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +0.01	APR +0.03	AUG +0.05	REF = 644 SIM = –	STORM U/S F 0.0 W -0.004 SP 0.0 SU +0.002
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.0987	0.9782	0.4872	0.0642		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-110

SENSITIVITY ANALYSIS OF OFSL (4974)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW61	497.4	- 90	Δ% OF R/O	+0.7	+2.7	+1.2	-1.2	-2.94	+0.25
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 33	STORM U/S F -0.008 W -0.030 SP -0.013 SU +0.013
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0450	1.6522	0.7580	0.0580		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW63	2487	- 50	Δ% OF R/O	+0.07	+0.80	+0.04	-0.16	–	–
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = –	STORM U/S F 0.0 W -0.016 SP 0.0 SU +0.032
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0447	1.6221	0.7494	0.0586		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW62	7461	+ 50	Δ% OF R/O	-0.03	-0.55	+0.03	+0.09	–	–
			STORM R/F	2.16	1.91	3.49	2.79	REF =34 SIM = –	STORM U/S F 0.0 W -0.011 SP 0.0 SU +0.001
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0447	1.600	0.7493	0.0587		
			REF (R/F/R/O)	48	1.18	4.65	46.5		

6-138

TABLE 6-111

SENSITIVITY ANALYSIS OF OFSL (3415)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW61	341.5	- 90	Δ% OF R/O	+1.4	-0.3	-0.1	-1.0	0.0	+0.22
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	SIM = 23	F -0.016
			PERT. R/O (IN.)	0.0961	2.1635	0.5203	0.1161		W +0.004
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP +0.001 SU +0.011
RW63	1707	- 50	Δ% OF R/O	+0.12	-0.21	-0.11	-0.17	–	–
			STORM R/F	2.51	3.11	1.70	2.21	REF =23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	SIM = –	F -0.002
			PERT. R/O (IN.)	0.0949	2.1650	0.5204	0.1170		W +0.004
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP +0.002 WU +0.003
RW62	5123	+ 50	Δ% OF R/O	-0.05	+0.11	+0.05	+0.05		
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	SIM =	F -0.001
			PERT. R/O (IN.)	0.0947	2.1720	0.5213	0.1173		W +0.002
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SP +0.001 SU +0.001

TABLE 6-112

SENSITIVITY ANALYSIS OF OFSL (4692)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW61	469.2	- 90	Δ% OF R/O	0.0	+2.5	+2.7	-0.3	0.0	+0.13
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	SIM = 4	F 0.0
			PERT. R/O (IN.)	0.036	1.9542	0.9466	0.0858		W -0.028
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP -0.030 SU +0.003
RW63	2346	- 50	Δ% OF R/O	+0.04	+0.42	+0.48	-0.07	–	–
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	SIM = –	F 0.0
			PERT. R/O (IN.)	0.0358	1.9150	0.9259	0.0860		W -0.008
			REF (R/F/R/O)	30	1.06	1.97	25.8		SP -0.010 SU +0.001
RW62	7038	+ 50	Δ% OF R/O	+0.04	-0.16	-0.17	-0.02		
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086	SIM =	F 0.0
			PERT. R/O (IN.)	0.0358	1.9039	0.9199	0.0861		W -0.003
6-139			REF (R/F/R/O)	30	1.06	1.97	25.8		SP -0.003 SU 0.0

TABLE 6-113

SENSITIVITY ANALYSIS OF OFSL (6915)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW61	691.5	- 90	Δ% OF R/O	0.0	+1.6	-0.3	+0.5	0.0	+0.18
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F 0.0
			PERT. R/O (IN.)	0.029	1.5820	0.6082	0.1276	SIM = 40	W -0.018
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP +0.003 SU -0.005
RW63	3457	- 50	Δ% OF R/O	-0.06	+0.17	-0.14	+0.04	–	–
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F +0.001
			PERT. R/O (IN.)	0.0294	1.5596	0.6089	0.1269	SIM = –	W -0.003
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP +0.002 SU 0.0
RW62	10373	+ 50	Δ% OF R/O	-0.07	-0.06	+0.01	-0.03		
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40	F +0.001
			PERT. R/O (IN.)	0.0294	1.5560	0.6098	0.1268	SIM =	W -0.001
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SP 0.0 SU 0.0

TABLE 6-114

SENSITIVITY ANALYSIS OF OFSL (5921)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW61	592.1	- 90	Δ% OF R/O	+0.1	+6.7	+12.3	-2.4	-11.11	+0.30
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9	F -0.001
			PERT. R/O (IN.)	0.1504	0.8210	0.6597	0.0305	SIM = 8	W -0.074
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP -0.137 SU +0.027
RW63	2955	- 50	Δ% OF R/O	+0.01	+1.06	+2.31	-0.42		
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9	F 0.0
			PERT. R/O (IN.)	0.1502	0.7775	0.6012	0.0311	SIM =	W -0.021
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP -0.046 SU +0.008
RW62	8887	+ 50	Δ% OF R/O	-0.01	-0.41	-1.0	+0.17		
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9	F 0.0
			PERT. R/O (IN.)	0.1502	0.7662	0.5818	0.0313	SIM =	W -0.008
6-140			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SP -0.020 SU +0.003

TABLE 6-115

SENSITIVITY ANALYSIS OF UFSL - 90% PERTURBATION
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/67 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW 61			Δ% OF R/O	+0.2	+0.6	+0.6	-1.3	-2.02	+0.42
			Δ% OF MONTHLY R/O	OCT 0.0	JAN -0.22	APR +0.04	AUG -1.55	9/15/68	STORM U/S
REGIONAL (6914 REF)	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.002 W -0.007
			PERT. R/O	0.0989	0.9861	0.490	0.0633	SIM = 631	SP -0.001
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.014
RUN ID RW 61			Δ% OF R/O	+0.7	+2.7	+1.2	-1.2	-2.94	+0.25
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.008 W -0.030
			PERT. R/O	0.0450	1.6522	0.7580	0.0580	SIM = 33	SP -0.013
(4974 REF)			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.013
RUN ID RW 61			Δ% OF R/O	+1.4	-0.3	-0.1	-1.0	0.0	+0.22
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.016 W +0.004
			PERT. R/O	0.0961	2.1635	0.5203	0.1161	SIM = 23	SP +0.001
(3415 REF)			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.011
RUN ID RW 61			Δ% OF R/O	0.0	+2.5	+2.7	-0.3	0.0	+0.13
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W -0.028
			PERT. R/O	0.036	1.9542	0.9466	0.0858	SIM = 4	SP -0.030
(4692 REF)			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.003
RUN ID RW 61			Δ% OF R/O	0.0	+1.6	-0.3	+0.5	0.0	+0.18
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F 0.0 W -0.018
			PERT. R/O	0.029	1.5820	0.6082	0.1276	SIM = 40	SP +0.003
(6915 REF)			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.005
RUN ID RW 61			Δ% OF R/O	+0.1	+6.7	+12.3	-2.4	-11.11	+0.30
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.001 W -0.074
			PERT. R/O	0.1504	0.8210	0.6597	0.0305	SIM = 8	SP -0.137
(5921 REF)			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.027

TABLE 6-116

SENSITIVITY ANALYSIS OF OFSL -50% PERTURBATION
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID TO 75			Δ% OF R/O	+22.9	+1.3	-0.6	+7.9	-5.1	+0.24
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.458 W -0.026
(1550 REF)			PERT. R/O	0.22	2.34	1.93	0.28	SIM = 7.5	SP +0.012
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.158
RUN ID 30			Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F 0.0 W 0.0
(1000 REF)			PERT. R/O	0.033	0.039	0.916	0.043	SIM = 3.0	SP 0.0
			REF (R/F/R/O)	91	——	1.94	25		SU 0.0
RUN ID RW 63			Δ% OF R/O	+0.02	+0.24	+0.02	-0.27	--	--
			Δ% OF MONTHLY R/O	OCT +0.01	JAN -0.05	APR -0.05	AUG -0.29	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F 0.0 W -0.005
(6914 REF)			PERT. R/O	0.988	0.9822	0.4873	0.06395	SIM = --	SP 0.0
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.005
RUN ID RW 63			Δ% OF R/O	+0.07	+0.80	+0.04	-0.16	--	--
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F 0.0 W -0.016
(4974 REF)			PERT. R/O	0.0447	1.6221	0.7494	0.0586	SIM = --	SP 0.0
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.032
RUN ID RW 63			Δ% OF R/O	+0.12	-0.21	-0.11	-0.17	--	--
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.002 W +0.004
(3415 REF)			PERT. R/O	0.0949	2.1650	0.5204	0.1170	SIM = --	SP +0.002
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.003
RUN ID RW 63			Δ% OF R/O	+0.04	+0.42	+0.48	-0.07	--	--
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W -0.008
(4692 REF)			PERT. R/O	0.0358	1.9150	0.9259	0.0860	SIM = --	SP -0.010
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.001
RUN ID RW 63			Δ% OF R/O	-0.06	+0.17	-0.14	+0.04	--	--
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +0.001 W -0.003
(6915 REF)			PERT. R/O	0.0294	1.5596	0.6089	0.1269	SIM = --	SP +0.002
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU 0.0
RUN ID RW 63			Δ% OF R/O	+0.01	+1.06	+2.31	-0.42		
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F 0.0 W -0.021
(5921 REF)			PERT. R/O	0.1502	0.7775	0.6012	0.0311	SIM =	SP -0.046
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.008

TABLE 6-117

SENSITIVITY ANALYSIS OF OFSL +50% PERTURBATION

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID TO 76			Δ% OF R/O	-12.2	-0.8	+0.4	-4.7	+3.80	-0.14
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL (1550 REF)	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.244 W -0.016
			PERT. R/O	~ 0.15	2.29	1.95	0.24	SIM = 8.2	SP +0.008
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU -0.094
RUN ID 31			Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW (1000 REF)	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F 0.0 W 0.0
			PERT. R/O	0.033	0.039	0.916	0.043	SIM = 3.0	SP 0.0
			REF (R/F/R/O)	91	---	1.94	25		SU 0.0
RUN ID RW 62			Δ% OF R/O	-0.01	-0.17	+0.01	+0.12	--	--
			Δ% OF MONTHLY R/O	OCT 0.0	JAN +0.01	APR +0.03	AUG +0.05	9/15/68	STORM U/S
REGIONAL (6914 REF)	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F 0.0 W -0.004
			PERT. R/O	0.0987	0.9782	0.4872	0.0642	SIM = --	SP 0.0
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +0.002
RUN ID RW 62			Δ% OF R/O	-0.03	-0.55	+0.03	+0.09	--	--
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F 0.0 W -0.011
(4974 REF)			PERT. R/O	0.0447	1.600	0.7493	0.0587	SIM = --	SP 0.0
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +0.001
RUN ID RW 62			Δ% OF R/O	-0.05	+0.11	+0.05	+0.05		
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.001 W +0.002
(3415 REF)			PERT. R/O	0.0947	2.1720	0.5213	0.1173	SIM =	SP +0.001
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +0.001
RUN ID RW 62			Δ% OF R/O	+0.04	-0.16	-0.17	-0.02		
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W -0.003
(4692 REF)			PERT. R/O	0.0358	1.9039	0.9199	0.0861	SIM =	SP -0.003
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU 0.0
RUN ID RW 62			Δ% OF R/O	-0.07	-0.06	+0.01	-0.03		
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +0.001 W -0.001
(6915 REF)			PERT. R/O	0.0294	1.5560	0.6098	0.1268	SIM =	SP 0.0
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU 0.0
RUN ID RW62			Δ% OF R/O	-0.01	-0.41	-1.0	+0.17		
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F 0.0 W -0.008
(5921 REF)			PERT. R/O	0.1502	0.7662	0.5818	0.0311	SIM =	SP -0.020
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.003

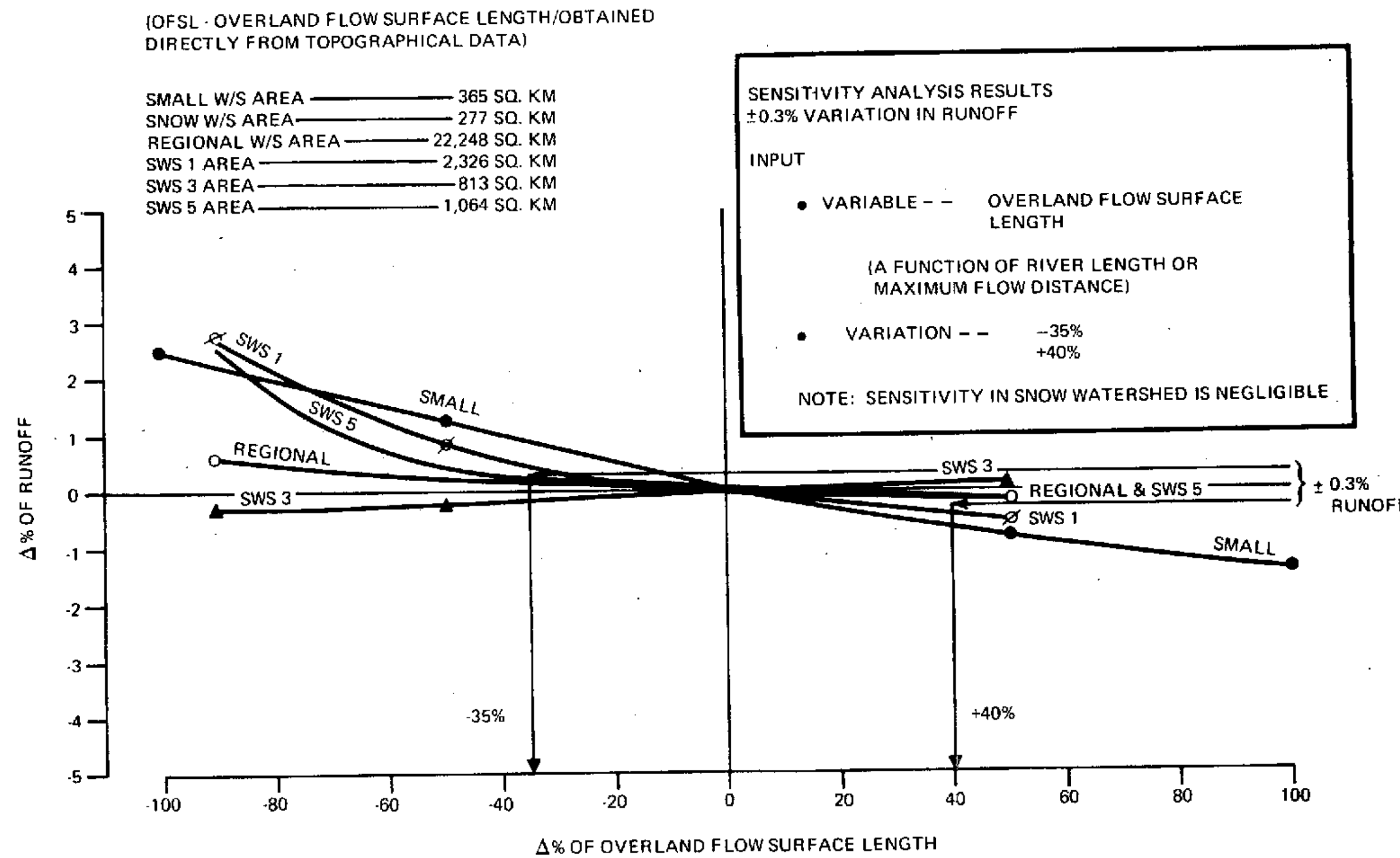


Figure 6-23. Overland Flow Surface Length Study, Winter Storms

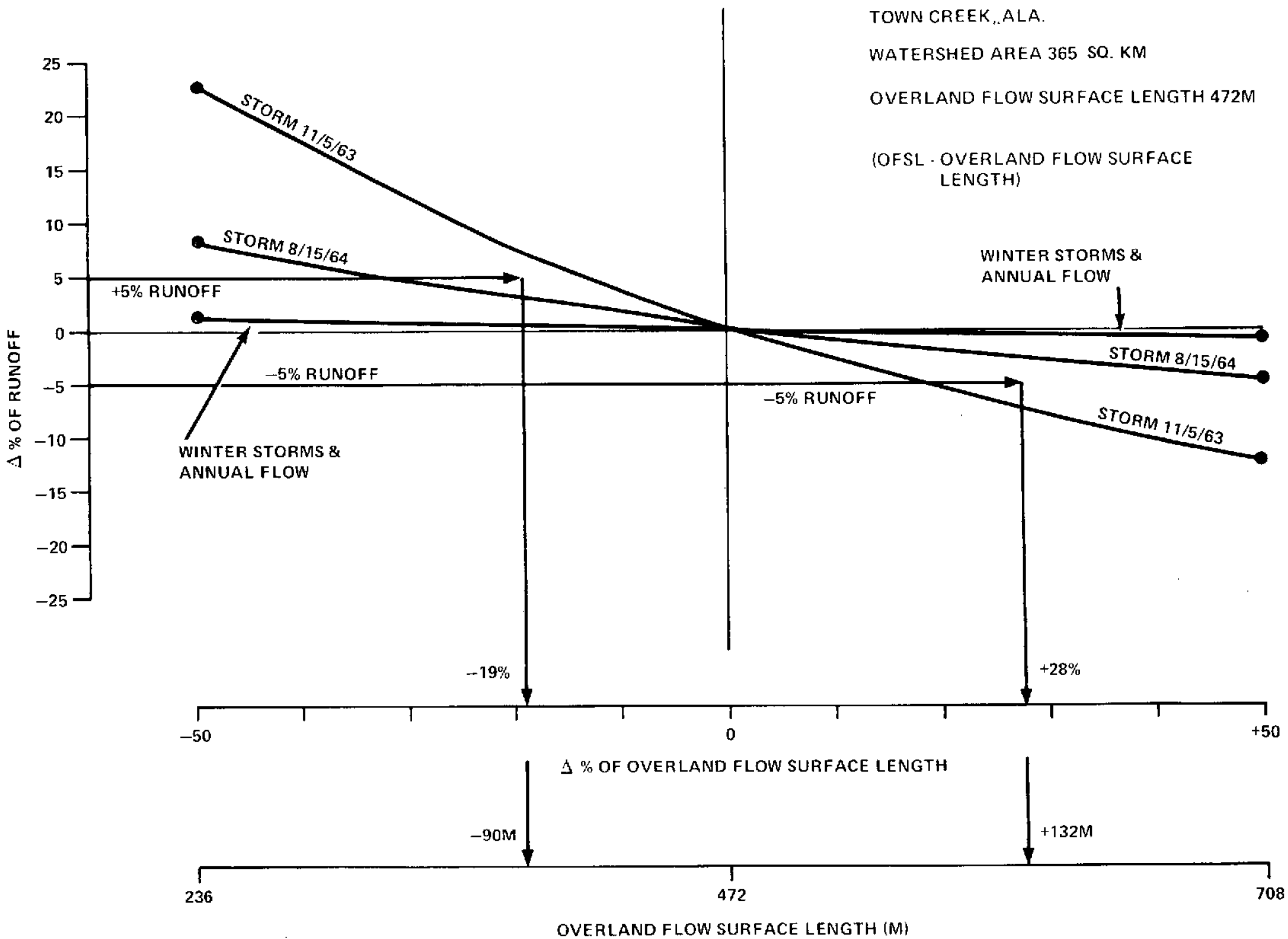


Figure 6-24. Overland Flow Surface Length Study, Small Watershed

6.3.12 OFMN, OVERLAND FLOW ROUGHNESS COEFFICIENT

OFMN is Manning's n roughness coefficient for overland flow on soil surfaces and may be estimated from Table 6-118.

The parameter is indirectly obtainable from land-use classification using the above table.

Sensitivity analysis results of the small watershed shows that OFMN is most influential during the fall season, when it has a unit sensitivity of -0.458 for a perturbation of -50%. For all practical purposes it has no influence in the other watersheds.

The overland flow contribution to streamflow is inversely proportional to OFMN, as it is to OFSL. In the fall the relative contribution of overland flow to streamflow is greater than in other seasons. The influence of OFMN is accordingly greater in the fall.

Results appear in Tables 6-119 through 6-127 and Figure 6-25. For Tables of OFMN perturbed by -50% and +50%, the results are approximately the same as for OFSL, Table 6-116 and 6-117.

Table 6-118. Manning's Roughness Coefficient for Overland for Various Surface Types (Chow)

WATERSHED SURFACE	MANNING'S n
Smooth Asphalt or Concrete (Trowel Finish)	.013
Rough Asphalt	.016
Concrete (Unfinished)	.017
Smooth Earth	.018
Firm Gravel	.020
Cemented Rubble Masonry	.025
Pasture (Short Grass)	.030
Pasture (Heavy Grass) or Cultivated Area (Row Crops)	.035
Cultivated Area (Field Crops)	.040
Scattered Brush, Heavy Weeds, or Light Brush & Trees (Winter)	.050
Light Brush & Trees (Summer)	.060
Dense Brush (Winter)	.070
Dense Brush (Summer) or Heavy Timer	.100

TABLE 6-119

SENSITIVITY ANALYSIS OF OFMN (0.05)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
D079	0.001	-100	Δ% OF R/O	+90.7	+2.6	-0.6	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = –	STORM U/S F -0.907 W -0.026 SP +0.006 SU –
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.33	2.37	1.93	–		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
T080	0.025	- 50	Δ% OF R/O	+22.9	+1.3	-0.6	+7.9	-5.06	+0.24
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 7.5	STORM U/S F -0.458 W -0.026 SP +0.012 SU -0.158
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.22	2.34	1.93	0.28		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
T081	0.075	+ 50	Δ% OF R/O	-12.2	-0.8	+0.4	-4.7	+3.80	-0.14
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 8.2	STORM U/S F -0.244 W -0.016 SP +0.008 SU -0.094
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.15	2.29	1.95	0.24		
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		
D082	0.10	+100	Δ% OF R/O	-19.7	-1.4	+0.7	–	–	–
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = –	STORM U/S F -0.197 W -0.014 SP +0.007 SU –
			REF. R/O (IN)	0.175	2.31	1.94	0.255		
			PERT. R/O (IN)	0.14	2.28	1.95	–		
			REF (R/F/R/O)	17.9	3.19	1.47	8.3		

TABLE 6-120

SENSITIVITY ANALYSIS OF OFMN (0.35)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
37	0.0001	-100	Δ% OF R/O	0.0	0.0	+3.2	-0.2	0.0	+0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP -0.032 SU +0.002
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.945	0.043		
			REF (R/F/R/O)	91	--	1.94	25		
39	0.175	- 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	--	1.94	25		
42	0.525	+ 50	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
			REF (R/F/R/O)	91	--	1.94	25		
44	0.70	+100	Δ% OF R/O	0.0	0.0	0.0	0.0	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.0	STORM U/S F 0.0 W 0.0 SP 0.0 SU 0.0
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.039	0.916	0.043		
6-148			REF (R/F/R/O)	91	--	1.94	25		

TABLE 6-121

SENSITIVITY ANALYSIS OF OFMN (0.066)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	+5.4	+1.4	+1.7	-3.6	-7.45	+1.25
			Δ% OF MONTHLY R/O	OCT +1.69	JAN -0.85	APR +0.50	AUG -3.49	REF = 644 SIM = 596	STORM U/S F -0.054 W -0.014 SP -0.017 SU -0.036
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.1040	0.9937	0.4953	0.0618		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
66	0.033	- 50	Δ% OF R/O	+0.02	+0.24	+0.01	-0.27	–	–
			Δ% OF MONTHLY R/O	OCT +0.01	JAN -0.05	APR -0.05	AUG -0.29	REF = 644 SIM = –	STORM U/S F 0.0 W -0.005 SP 0.0 SU -0.005
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.0988	0.9822	0.4872	0.0639		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
65	0.099	+ 50	Δ% OF R/O	-0.01	-0.17	+0.02	+0.12	–	–
			Δ% OF MONTHLY R/O	OCT 0.0	JAN 0.01	APR +0.03	AUG +0.13	REF = 644 SIM = –	STORM U/S F 0.0 W -0.003 SP 0.0 SU +0.002
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.0987	0.9782	0.4873	0.0642		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-122

SENSITIVITY ANALYSIS OF OFMN (0.056)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ% PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	+21.5	+5.9	+8.3	-5.4	-8.82	+0.86
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 31	STORM U/S F -0.215 W -0.059 SP -0.083 SU -0.054
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0543	1.7041	0.8115	0.0555		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
66	0.028	- 50	Δ% OF R/O	+0.07	+0.80	+0.04	-0.16	–	–
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = –	STORM U/S F -0.001 W -0.016 SP 0.0 SU +0.003
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0447	1.6221	0.7494	0.0586		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
65	0.084	+ 50	Δ% OF R/O	-0.03	-0.55	+0.03	+0.09	–	–
			STORM R/F	2.16	1.91	3.49	2.79	REF =34 SIM = –	STORM U/S F 0.0 W -0.011 SP 0.0 SU +0.002
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.0447	1.6005	0.7493	0.0587		
			REF (R/F/R/O)	48	1.18	4.65	46.5		

TABLE 6-123

SENSITIVITY ANALYSIS OF OFMN (0.07)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	+22.7	+1.3	+3.6	+2.6	-4.35	+0.62
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 22	STORM U/S F -0.227 W -0.013 SP -0.036 SU -0.026
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.1163	2.1988	0.5398	0.1204		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
66	0.035	- 50	Δ% OF R/O	+0.11	-0.21	-0.11	-0.17	–	–
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = –	STORM U/S F -0.002 W +0.004 SP +0.002 WU +0.003
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.0949	2.1650	0.5204	0.1171		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		
65	0.105	+ 50	Δ% OF R/O	-0.05	+0.11	+0.05	+0.05	–	–
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = --	STORM U/S F -0.001 W +0.002 SP +0.001 SU +0.001
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		
			PERT. R/O (IN.)	0.0948	2.1720	0.5213	0.1173		
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		

TABLE 6-124

SENSITIVITY ANALYSIS OF OFMN (0.068)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	0.0	+3.8	+5.1	-1.6	0.0	+0.36
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S F 0.0 W -0.038 SP -0.051 SU +0.016
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.036	1.9808	0.9688	0.0847		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
66	0.034	- 50	Δ% OF R/O	+0.04	+0.42	+0.48	-0.07	–	–
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = –	STORM U/S F 0.0 W -0.008 SP -0.010 SU +0.001
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.0358	1.9150	0.9259	0.0860		
			REF (R/F/R/O)	30	1.06	1.97	25.8		
65	0.102	+ 50	Δ% OF R/O	+0.04	-0.16	-0.17	-0.02	–	–
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = –	STORM U/S F 0.0 W -0.003 SP -0.003 SU 0.0
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		
			PERT. R/O (IN.)	0.0358	1.9039	0.9199	0.0861		
			REF (R/F/R/O)	30	1.06	1.97	25.8		

TABLE 6-125

SENSITIVITY ANALYSIS OF OFMN (0.065)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	+6.7	+6.4	+5.0	+25.9	-5.0	+1.01
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S F -0.067
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40 SIM = 38	W -0.064
			PERT. R/O (IN.)	0.0314	1.6573	0.6408	0.1597		SP -0.050
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.259
66	0.033	- 50	Δ% OF R/O	-0.06	+0.17	-0.14	+0.04	–	–
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S F +0.001
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40 SIM = –	W -0.003
			PERT. R/O (IN.)	0.0294	1.5596	0.6089	0.1270		SP -0.003
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU 0.0
65	0.098	+ 50	Δ% OF R/O	-0.07	-0.06	+0.01	-0.03	–	–
			STORM R/F	1.58	2.76	1.92	2.95		STORM U/S F -0.001
			REF. R/O (IN.)	0.029	1.557	0.610	0.127	REF = 40 SIM = --	W -0.001
			PERT. R/O (IN.)	0.0294	1.5560	0.6098	0.1269		SP 0.0
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU 0.0

TABLE 6-126

SENSITIVITY ANALYSIS OF OFMN (0.073)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
64	0.001	-100	Δ% OF R/O	+3.8	+10.7	+17.3	-5.7	-22.2	+1.63
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F -0.038
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = 7	W -0.107
			PERT. R/O (IN.)	0.1560	0.8519	0.6895	0.0295		SP -0.173
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.057
66	0.037	- 50	Δ% OF R/O	+0.01	+1.05	+2.30	-0.42	–	–
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F 0.0
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = –	W -0.021
			PERT. R/O (IN.)	0.1502	0.7775	0.6011	0.0311		SP -0.046
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.008
65	0.11	+ 50	Δ% OF R/O	-0.01	-0.41	-0.99	+0.17	–	--
			STORM R/F	1.35	1.37	1.91	0.50		STORM U/S F 0.0
			REF. R/O (IN.)	0.150	0.769	0.588	0.031	REF = 9 SIM = –	W -0.008
			PERT. R/O (IN.)	0.1502	0.7662	0.5818	0.0313		SP -0.020
6-151			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +0.003

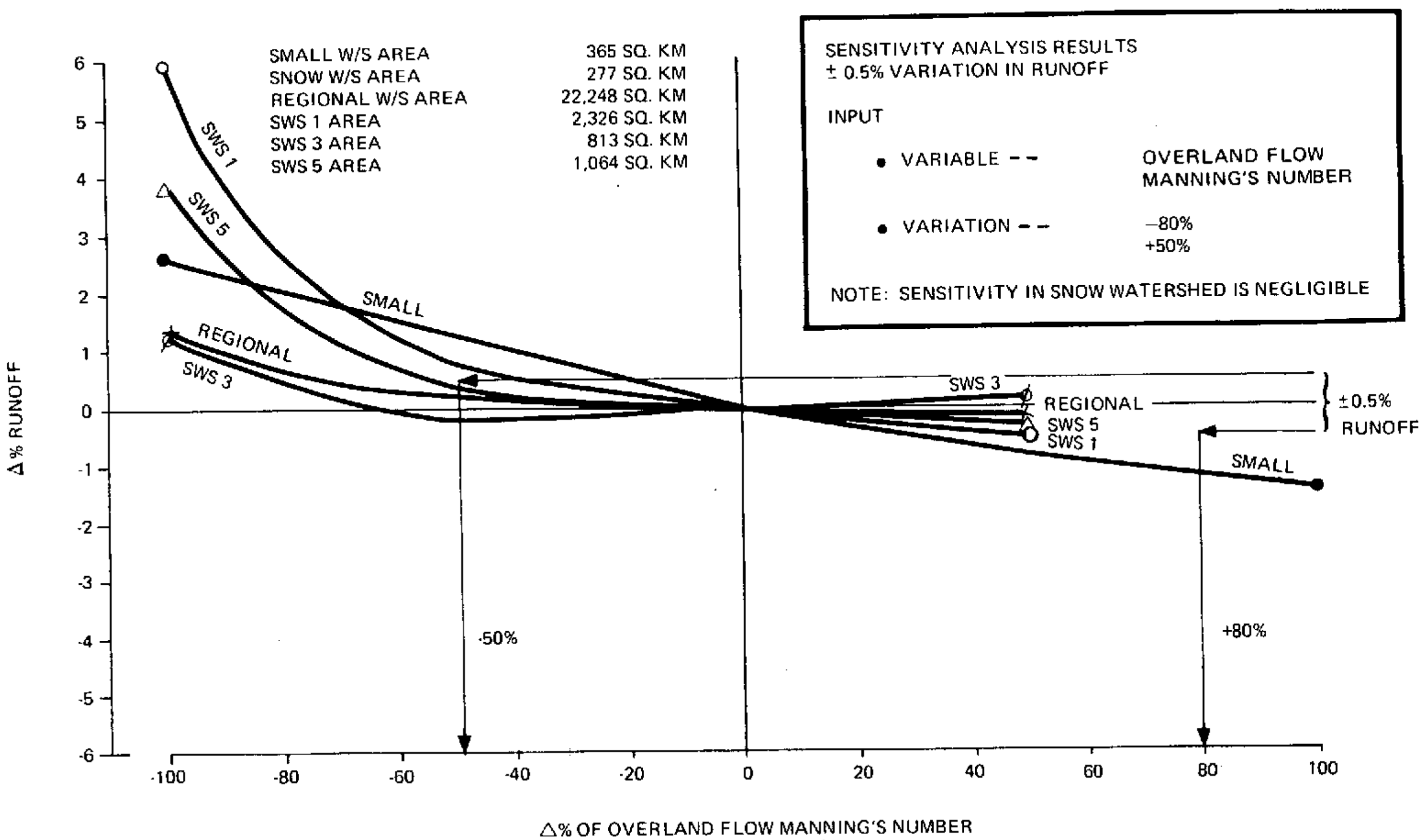
TABLE 6-127

SENSITIVITY ANALYSIS OF OFMN —100% PERTURBATION (0.048 – 0.35)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID D079			Δ% OF R/O	+90.7	+2.8	-0.6	---	---	---
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F -0.907 W -0.026
			PERT. R/O	0.33	2.37	1.93	---	SIM = ---	SP +0.006
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU ---
RUN ID 37			Δ% OF R/O	0.0	0.0	+3.2	-0.2	0.0	+0.01
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F 0.0 W 0.0
			PERT. R/O	0.033	0.039	0.945	0.043	SIM = 3.0	SP -0.032
			REF (R/F/R/O)	91	--	1.94	25		SU +0.002
RUN ID RW64			Δ% OF R/O	+5.4	+1.4	+1.7	- 3.6	-7.45	+1.25
			Δ% OF MONTHLY R/O	OCT +1.69	JAN - 0.85	APR +0.50	AUG - 3.49	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F - 0.054 W - 0.014
			PERT. R/O	0.1040	0.9937	0.4953	0.0618	SIM = 596	SP - 0.017
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU - 0.036
RUN ID RW64			Δ% OF R/O	+21.5	+5.9	+8.3	- 5.4	-8.82	+0.86
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.215 W -0.059
			PERT. R/O	0.0543	1.7041	0.8115	0.0555	SIM = 31	SP -0.083
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.054
RUN ID RW64			Δ% OF R/O	+22.7	+1.3	+3.6	+2.6	-4.35	+0.62
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.227 W -0.013
			PERT. R/O	0.1163	2.1988	0.5398	0.1204	SIM = 22	SP -0.036
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.026
RUN ID RW64			Δ% OF R/O	0.0	+3.8	+5.1	- 1.6	0.0	+0.36
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F 0.0 W -0.038
			PERT. R/O	0.036	1.9808	0.9688	0.0847	SIM = 4	SP -0.051
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +0.016
RUN ID RW64			Δ% OF R/O	+6.7	+6.4	+5.0	+25.9	-5.0	+1.01
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.067 W -0.064
			PERT. R/O	0.0314	1.6573	0.6408	0.1597	SIM = 38	SP -0.050
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.259
RUN ID RW64			Δ% OF R/O	+ 3.8	+10.7	+17.3	-5.7	-22.2	+1.63
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.038 W -0.107
			PERT. R/O	0.1560	0.8519	0.6895	0.0295	SIM = 7	SP -0.173
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.057

(OFMN - OVERLAND FLOW MANNING'S NUMBER/INDIRECTLY OBTAINABLE FROM LAND - USE CLASSIFICATION)



* A FUNCTION OF TYPE OF SURFACE, TYPE AND DENSITY OF VEGITATION AND FOREST COVERS

Figure 6-25. Overland Flow Manning's N Study, Winter Storms

6.3.13 RGPMB, RECORDING GAGE PRECIPITATION MULTIPLIER

This parameter permits adjustment of the precipitation data. If, during the calibration procedure, it is observed that simulated stream discharge values are consistently high or low, it may be due to a consistent under or over estimation of the precipitation gage data which may be corrected by this parameter.

The precipitation data can be directly obtainable from climatological data recorders, and eventually it will telemetered through communication satellites.

Sensitivity analysis (Tables 6-128 through 6-137 and Figure 6-26) show the models to be very sensitive to changes in RGPMB, the effect of which is to introduce a constant percentage bias in the precipitation input. Over a long period of time, this bias accumulates a large excess or deficiency in soil moisture, compounding the effects on output accuracy. It would be more realistic to introduce random errors in precipitation input, according to some probability density function, to represent the inability of the precipitation gages and preprocessing functions to synthesize a mean basin precipitation record. That would be a worthwhile undertaking for some future investigation. A small step in that direction was taken in the snowshed sensitivity analysis, when precipitation data was perturbed only during selected storms, as reported in Paragraph 6.3.15.

TABLE 6-128

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
S005	0.9	- 10	Δ% OF R/O	-40.3	-16.1	-14.4	-35.7	-22.78	-16.19
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 6.1	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255		F +4.030 W +1.610
			PERT. R/O (IN)	0.10	1.94	1.66	0.16		SP +1.440
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +3.570
S006	1.1	+ 10	Δ% OF R/O	+66.5	+15.8	+14.5	+45.4	+25.32	+16.55
			STORM R/F	3.13	3.19	2.87	2.16	REF = 7.9 SIM = 9.9	STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255		F +6.650 W +1.580
			PERT. R/O (IN)	0.29	2.68	2.22	0.37		SP +1.450
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +4.540

TABLE 6-129

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
45	0.9	- 10	Δ% OF R/O	-9.6	+19.3	-8.3	-25.2	-50.0	-18.56
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 1.5	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F +0.960 W +1.930
			PERT. R/O (IN.)	0.030	0.047	0.840	0.032		SP +0.830
			REF (R/F/R/O)	91	—	1.94	25		SU +2.520
46	1.1	+ 10	Δ% OF R/O	+10.7	-13.5	+9.3	+28.2	—	+18.99
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = —	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		F +1.070 W +1.350
			PERT. R/O (IN.)	0.036	0.034	1.002	0.055		SP +0.930
			REF (R/F/R/O)	91	—	1.94	25		SU +2.820

TABLE 6-130

SENSITIVITY ANALYSIS OF RGPMB (1.0)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-11.7	-18.2	-18.2	-22.5	-43.94	-18.83
			Δ% OF MONTHLY R/O	OCT -6.21	JAN -18.93	APR -17.15	AUG -23.64	REF = 644 SIM = 361	STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064		F +1.170 W +1.820
			PERT. R/O (IN)	0.09	0.80	0.40	0.05		SP +1.820
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU +2.250
RW02	1.1	+10	Δ% OF R/O	+12.6	+18.3	+18.5	+27.9	+80.90	+19.82
			Δ% OF MONTHLY R/O	OCT +6.21	JAN +19.07	APR +17.31	AUG +31.40	REF = 644 SIM = 1165	STORM U/S
			REF. R/O (IN)	0.099	0.980	0.487	0.064		F +1.260 W +1.830
			PERT. R/O (IN)	0.11	1.16	0.58	0.08		SP +1.850
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		SU +2.790

TABLE 6-131

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SUBWATERSHED NO. 1 2,326 SQ. KM

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

RUN ID	PARAM VALUE	Δ % PERTUR BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-13.6	-20.7	-18.7	-37.3	-47.06	-19.57
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 18	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F +1.360
			PERT. R/O (IN.)	0.04	1.28	0.61	0.04		W +2.070 SP +1.870
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +3.730
RW02	1.1	+10	Δ% OF R/O	+19.1	+21.1	+19.7	+49.7	+50.0	+20.53
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 68	STORM U/S
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		F +1.910 W +2.110
			PERT. R/O (IN.)	0.05	1.95	0.90	0.09		SP +1.970
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +4.970

TABLE 6-132

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-14.4	-16.3	-19.6	-22.0	-30.43	-17.71
			STORM R/F	2.51	3.11	1.70	2.21	REF = 23 SIM = 16	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F +1.440 W +1.630
			PERT. R/O (IN.)	0.08	1.82	0.42	0.09		SP +1.960
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +2.200
RW02	1.1	+10	Δ% OF R/O	+16.6	+16.4	+21.9	+27.6	+43.48	+18.37
			STORM R/F	2.51	3.11	1.70	2.21	REF =23 SIM = 33	STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117		F +1.660 W +1.640
			PERT. R/O (IN.)	0.11	2.53	0.64	0.15		SP +2.190
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		WU +2.760

TABLE 6-133

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-12.2	-17.6	-17.3	-14.6	-25.0	- -16.80
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 3	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F +1.220 W +1.760
			PERT. R/O (IN.)	0.03	1.57	0.76	0.07		SP +1.730
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +1.460
RW02	1.1	+10	Δ% OF R/O	+12.5	+17.9	+18.0	+15.3	+75.0	+17.26
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 7	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F +1.250 W +1.790
			PERT. R/O (IN.)	0.04	2.25	1.09	0.10		SP +1.800
6-156			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +1.530

TABLE 6-134

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-13.7	-19.0	-20.4	-37.5	-40.0	-19.0
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 24	STORM U/S F +1.370 W +1.900 SP +2.040 SU +3.750
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.26	0.49	0.08		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		
RW02	1.1	+10	Δ% OF R/O	+17.7	19.1	+22.5	+55.4	+57.5	+19.9
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 63	STORM U/S F +1.770 W +1.910 SP +2.250 SU +5.540
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		
			PERT. R/O (IN.)	0.03	1.85	0.75	0.20		
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		

TABLE 6-135

SENSITIVITY ANALYSIS OF RGPMB (1.0)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW03	0.9	-10	Δ% OF R/O	-7.1	-19.1	-20.8	-21.3	-33.33	-18.07
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 6	STORM U/S F +0.710 W +1.910 SP +2.080 SU +2.130
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.14	0.62	0.47	0.02		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW02	1.1	+10	Δ% OF R/O	+7.3	+19.1	+22.4	+26.0	+88.9	+18.92
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 17	STORM U/S F +0.730 W +1.910 SP +2.240 SU +2.600
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.16	0.92	0.72	0.04		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

6-157

TABLE 6-136

SENSITIVITY ANALYSIS OF RGPMB –10% PERTURBATION (1.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O	–40.3	–16.1	–14.4	–35.7	–22.78	–16.19
S005			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +4.030 W +1.610
			PERT. R/O	0.10	1.94	1.66	0.16	SIM = 6.1	SP +1.440
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +3.570
RUN ID			Δ% OF R/O	–9.6	+19.3	–8.3	–25.2	–50.0	–18.56
45			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F +0.960 W +1.930
			PERT. R/O	0.030	0.047	0.840	0.032	SIM = 1.5	SP +0.830
			REF (R/F/R/O)	91	——	1.94	25		SU +2.520
RUN ID RW 03			Δ% OF R/O	–11.7	–18.2	–18.2	–22.5	–43.94	–18.83
			Δ% OF MONTHLY R/O	OCT –6.21	JAN –18.93	APR –17.15	AUG –23.64	9/15/68	STORM U/S
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F +1.170 W +1.820
			PERT. R/O	0.09	0.80	0.40	0.05	SIM = 361	SP +1.820
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +2.250
RUN ID RW 03			Δ% OF R/O	–13.6	–20.7	–18.7	–37.3	–47.06	–19.57
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F +1.360 W +2.070
			PERT. R/O	0.04	1.28	0.61	0.04	SIM = 18	SP +1.870
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +3.730
RUN ID RW 03			Δ% OF R/O	–14.4	–16.3	–19.6	–22.0	–30.43	–17.71
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F +1.440 W +1.630
			PERT. R/O	0.08	1.82	0.42	0.09	SIM = 16	SP +1.960
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +2.200
RUN ID RW 03			Δ% OF R/O	–12.2	–17.6	–17.3	–14.6	–25.0	–16.80
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F +1.220 W +1.760
			PERT. R/O	0.03	1.57	0.76	0.07	SIM = 3	SP +1.730
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +1.460
RUN ID RW 03			Δ% OF R/O	–13.7	–19.0	–20.4	–37.6	–40.0	–19.0
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +1.370 W +1.900
			PERT. R/O	0.03	1.26	0.49	0.08	SIM = 24	SP +2.040
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU +3.750
RUN ID RW 03			Δ% OF R/O	–7.1	–19.1	–20.8	–21.3	–33.33	–18.07
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F +0.710 W +1.910
			PERT. R/O	0.14	0.62	0.47	0.02	SIM = 6	SP +2.080
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +2.130

TABLE 6-137

SENSITIVITY ANALYSIS OF RGPMB +10% PERTURBATION (1.0)

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID S006 SMALL	365	46	Δ% OF R/O	+66.5	+16.8	+14.5	+45.4	+25.32	+16.55
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
			REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F +6.650
			PERT. R/O	0.29	2.68	2.22	0.37	SIM = 9.9	W +1.580 SP +1.450
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU +4.540
RUN ID 46 SNOW	277	32	Δ% OF R/O	+10.7	−13.5	+9.3	+28.2	––	+18.99
			STORM R/F	10/18/67 2.99	4/21/68 0.0	5/10/68 1.78	8/13/68 1.09	9/7/68	STORM U/S
			REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F +1.070
			PERT. R/O	0.036	0.034	1.002	0.055	SIM = ––	W +1.350 SP +0.930
			REF (R/F/R/O)	91	––	1.94	25		SU +2.820
RUN ID RW 02 REGIONAL	22,248	41	Δ% OF R/O	+12.6	+18.3	+18.5	+27.9	+80.90	+19.82
			Δ% OF MONTHLY R/O	OCT	JAN	APR	AUG	9/15/68	STORM U/S
			REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F +1.260
			PERT. R/O	0.11	1.16	0.58	0.08	SIM = 1165	W +1.830 SP +1.850
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU +2.790
RUN ID RW 02 SUB-WATERSHED NO. 1	2,326	50	Δ% OF R/O	+19.1	+21.1	+19.7	+49.7	+50.0	+20.53
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
			REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F +1.910
			PERT. R/O	0.05	1.95	0.90	0.09	SIM = 68	W +2.110 SP +1.970
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU +4.970
RUN ID RW 02 SUB-WATERSHED NO. 3	813	50	Δ% OF R/O	+16.6	+16.4	+21.9	+27.6	+43.48	+18.37
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
			REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F +1.660
			PERT. R/O	0.11	2.53	0.64	0.15	SIM = 33	W +1.640 SP +2.190
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU +2.760
RUN ID RW 02 SUB-WATERSHED NO. 5	1,064	37	Δ% OF R/O	+12.5	+17.8	+18.0	+15.3	+75.0	+17.26
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
			REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F +1.250
			PERT. R/O	0.04	2.25	1.09	0.10	SIM = 7	W +1.790 SP +1.800
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU +1.530
RUN ID RW 02 SUB-WATERSHED NO. 7	1,111	40	Δ% OF R/O	+17.7	+19.1	+22.5	+55.4	+57.5	+19.9
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
			REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F +1.770
			PERT. R/O	0.03	1.85	0.75	0.20	SIM = 63	W +1.910 SP +2.250
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU +5.540
RUN ID RW 02 SUB-WATERSHED NO. 11	2,551	30	Δ% OF R/O	+7.3	+19.1	+22.4	+26.0	+88.9	+18.92
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
			REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F +0.730
			PERT. R/O	0.16	0.92	0.72	0.04	SIM = 17	W +1.910 SP +2.240
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU +2.600

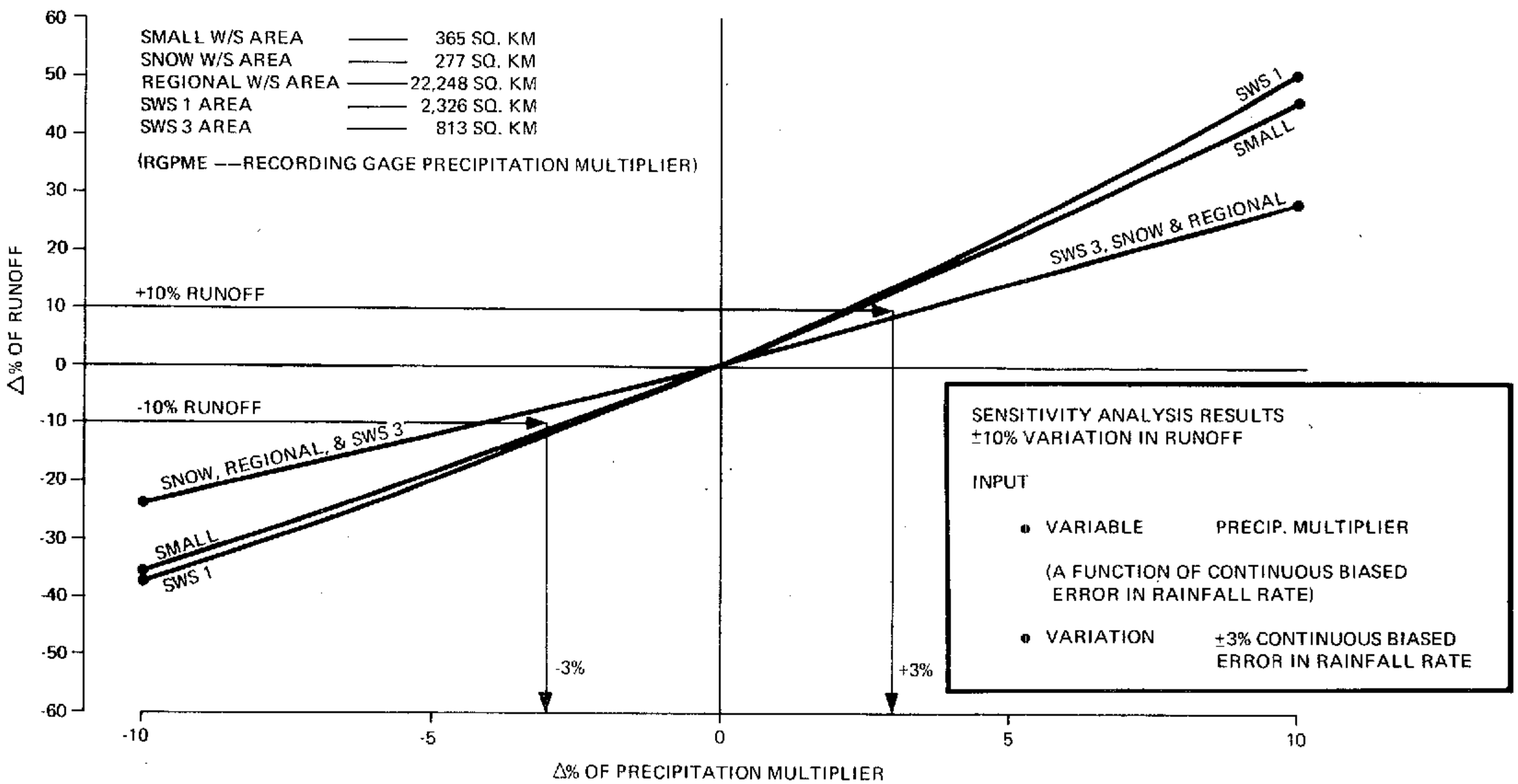


Figure 6-26. Precipitation Multiplier Study Fall Storms

6.3.14 EVAPORATION AND MEAN NUMBER OF RAINY DAYS

The model uses lake evaporation data to estimate evapotranspiration losses from the upper zone or, in the event all upper zone moisture has evaporated, from soil moisture storage.

Information on evaporation is the most difficult climatological data to obtain for most watersheds. So few evaporation pan records are available that only by coincidence will one be found close to a watershed being modeled. If one does have good information, daily pan evaporation totals and monthly pan evaporation coefficients can be read directly.

The evaporation data used for the small watershed is daily pan evaporation totals and monthly pan evaporation coefficients. All the monthly pan evaporation coefficients were perturbed ±10%.

If the closest evaporation pan is too far away for the daily weather-related fluctuations in evaporation totals to be indicative of conditions over the watershed, or if it is desired to shorten the job of estimating evaporation from climatological data, pan evaporation totals may be read as average values over fixed ten-days periods (Table 6-138). The model has been programmed to adjust the potential evaporation total during rainy days (rainfall equal to or greater than 0.01 inch) to half what it would be if no rain occurred.

The evaporation data used for the snow watershed is average ten-days periods and monthly pan evaporation coefficients. The ten-day averages were perturbed by ±20% and ±50%, but only during storms.

Where evaporation data is particularly sparse or a large number of watersheds are to be modeled in an area where a single evaporation pan must be used to distributed a geographically variable total annual pan evaporation over the year, a further data simplification is possible by using an estimate of the potential average annual lake evaporation (EPAET) and the mean annual number of days with measurable rainfall (MNRD).

The evaporation data used for the regional watershed and all its subwatersheds is the potential average annual lake evaporation (EPAET) and the mean annual number of days (MNRD) with measurable rainfall calculated in a special program.

The evaporation data can be directly obtainable from climatological data recorders, and eventually it will be telemetered through communication satellites from data collection sites.

Sensitivity analysis indicate that the evaporation input data is most influential during the fall and summer seasons. The average unit sensitivity is +2.0 for the evaporation data during summer, and -0.5 for the mean number of rainy days. The results appear in Tables 6-139 through 6-150 and Figures 6-27 and 6-28.

Table 6-138. Ten-Day Intervals for Averaging Evaporation Data

OCTOBER	1-OCTOBER	10	APRIL	1-APRIL	10
OCTOBER	11-OCTOBER	20	APRIL	11-APRIL	20
OCTOBER	21-OCTOBER	30	APRIL	21-APRIL	30
OCTOBER	31-NOVEMBER	9	MAY	1-MAY	10
NOVEMBER	10-NOVEMBER	19	MAY	11-MAY	20
NOVEMBER	20-NOVEMBER	29	MAY	21-MAY	30
NOVEMBER	30-DECEMBER	9	MAY	31-JUNE	9
DECEMBER	10-DECEMBER	19	JUNE	10-JUNE	19
DECEMBER	20-DECEMBER	31	JUNE	20-JUNE	29
JANUARY	1-JANUARY	10	JUNE	30-JULY	9
JANUARY	11-JANUARY	20	JULY	10-JULY	19
JANUARY	21-JANUARY	30	JULY	20-JULY	29
JANUARY	31-FEBRUARY	9	JULY	30-AUGUST	8
FEBRUARY	10-FEBRUARY	19	AUGUST	9-AUGUST	18
FEBRUARY	20-MARCH	1*	AUGUST	19-AUGUST	28
MARCH	2-MARCH	11	AUGUST	29-SEPTEMBER	7
MARCH	12-MARCH	21	SEPTEMBER	8-SEPTEMBER	17
MARCH	22-MARCH	31	SEPTEMBER	18-SEPTEMBER	27
			SEPTEMBER	28-SEPTEMBER	30

*This is an eleven-day interval on leap years.

TABLE 6-139

SENSITIVITY ANALYSIS OF EVAPORATION (ALL PAN COEFF.S)

SMALL WATERSHED 365 SQ. KM

ANNUAL R/F = 58.23 IN
EVAPOTRANSPIRATION NET = 24.24 IN
TOTAL OBSERVED ANNUAL R/O = 31.38 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 11/4/63 FALL	1/23/64 WINTER	5/1/64 SPRING	8/14/64 SUMMER	9/27/64 LOW FLOW	ANNUAL FLOW
T157		-10	Δ% OF R/O	+5.8	+1.4	+3.4	+32.1	+16.46	+4.11
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F −0.580
			PERT. R/O (IN)	0.19	2.35	2.00	0.34	SIM = 9.2	W −0.140
									SP −0.340
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU −3.210
T162		+10	Δ% OF R/O	-5.1	−1.4	−2.4	−21.0	−12.66	−3.78
			STORM R/F	3.13	3.19	2.87	2.16		STORM U/S
			REF. R/O (IN)	0.175	2.31	1.94	0.255	REF = 7.9	F −0.510
			PERT. R/O (IN)	0.17	2.28	1.89	0.20	SIM = 6.9	W −0.140
									SP −0.240
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU −2.100

TABLE 6-140

SENSITIVITY ANALYSIS OF STORM EVAPORATION (10 DAY PERIODS)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
50A		−50	Δ% OF R/O	+11.3	+27.0	+2.3	+7.1	+463.3	+5.66
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F −0.226
			PERT. R/O (IN.)	0.036	0.050	0.937	0.046	SIM = 16.9	W −0.540
									SP −0.046
			REF (R/F/R/O)	91	—	1.94	25		SU −0.142
51A		−20	Δ% OF R/O	+4.4	+8.8	+0.9	+2.7	+123.33	+1.74
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F −0.220
			PERT. R/O (IN.)	0.034	0.043	0.925	0.044	SIM = 6.7	W −0.440
									SP −0.045
			REF (R/F/R/O)	91	—	1.94	25		SU −0.135
52A		+20	Δ% OF R/O	−4.3	−8.0	−0.9	−2.6	−30.0	−1.26
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F −0.215
			PERT. R/O (IN.)	0.031	0.036	0.908	0.042	SIM = 2.1	W −0.400
									SP −0.045
			REF (R/F/R/O)	91	—	1.94	25		SU −0.130
53A		+50	Δ% OF R/O	−8.6	−15.1	−2.1	−6.0	−36.67	−2.36
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F −0.172
			PERT. R/O (IN.)	0.030	0.033	0.897	0.041	SIM = 1.9	W −0.302
									SP −0.042
6-163			REF (R/F/R/O)	91	—	1.94	25		SU −0.120

TABLE 6-141A

SENSITIVITY ANALYSIS OF EPAET (38)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW123	30.4	−20	Δ% OF R/O	+6.1	+5.3	+16.3	+46.4	+170.19	+13.27
			Δ% OF MONTHLY R/O	OCT +3.39	JAN +6.85	APR +8.96	AUG +55.81	REF = 644 SIM =1740	STORM U/S F −0.305 W −0.265 SP −0.815 SU −2.320
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	1.03	0.57	0.09		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW122	45.6	+20	Δ% OF R/O	−5.2	−4.9	−14.2	−20.0	−49.5	−10.03
			Δ% OF MONTHLY R/O	OCT −3.39	JAN −6.11	APR −8.46	AUG −22.48	REF = 644 SIM = 325	STORM U/S F −0.260 W −0.245 SP −0.710 SU −1.000
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.09	0.93	0.42	0.05		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-141B

SENSITIVITY ANALYSIS OF MNRD (107)

REGIONAL WATERSHED 22,248 SQ. KM

ANNUAL R/F = 41.89 IN
EVAPOTRANSPIRATION NET = 32.90 IN
TOTAL OBSERVED ANNUAL R/O = 15.41 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/21/68 WINTER	5/9/68 SPRING	8/11/68 SUMMER	9/15/68 LOW FLOW	ANNUAL FLOW
RW125	86	−20	Δ% OF R/O	+1.4	+1.8	+4.1	+7.7	+26.1	+3.09
			Δ% OF MONTHLY R/O	OCT +0.56	JAN +1.95	APR +2.42	AUG +8.91	REF = 644 SIM = 812	STORM U/S F −0.070 W −0.090 SP −0.205 SU −0.385
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	1.00	0.51	0.07		
			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		
RW124	128	+20	Δ% OF R/O	−1.3	−1.7	−3.9	−6.2	−17.4	−2.84
			Δ% OF MONTHLY R/O	OCT −1.13	JAN −1.87	APR −2.38	AUG −6.98	REF = 644 SIM = 532	STORM U/S F −0.065 W −0.085 SP −0.195 SU −0.310
			REF. R/O (IN)	0.099	0.980	0.487	0.064		
			PERT. R/O (IN)	0.10	0.96	0.47	0.06		
6-164			REF. MONTHLY R/O (IN)	0.177	3.634	2.600	0.258		

TABLE 6-142A

SENSITIVITY ANALYSIS OF EPAET (50)

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

SUBWATERSHED NO. 1 2,326 SQ. KM

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW123	40	−20	Δ% OF R/O	+11.9	+6.5	+18.5	+96.9	+226.47	+14.61
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 111	STORM U/S F −0.595 W −0.325 SP −0.925 SU −4.845
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.05	1.71	0.89	0.12		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW122	60	+20	Δ% OF R/O	−9.6	−5.9	−15.2	−45.4	−55.9	−11.43
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 15	STORM U/S F −0.475 W −0.295 SP −0.760 SU −2.270
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.51	0.64	0.03		
			REF (R/F/R/O)	48	1.18	4.65	46.5		

TABLE 6-142B

SENSITIVITY ANALYSIS OF MNRD (128)

ANNUAL R/F = 59.30 IN
EVAPOTRANSPIRATION NET = 40.29 IN
TOTAL OBSERVED ANNUAL R/O = 19.63 IN

SUBWATERSHED NO. 1 2,326 SQ. KM

RUN ID	PARAM VALUE	Δ% PERTURBATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/18/68 SUMMER	9/25/68 LOW FLOW	ANNUAL FLOW
RW125	102	−20	Δ% OF R/O	+2.6	+2.4	+4.6	+16.8	+35.3	+3.48
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 46	STORM U/S F −0.130 W −0.120 SP −0.230 SU −0.840
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.05	1.65	0.78	0.07		
			REF (R/F/R/O)	48	1.18	4.65	46.5		
RW124	154	+20	Δ% OF R/O	−2.5	−2.3	−4.3	−14.2	−26.5	−3.27
			STORM R/F	2.16	1.91	3.49	2.79	REF = 34 SIM = 25	STORM U/S F −0.125 W −0.115 SP −0.215 SU −0.710
			REF. R/O (IN.)	0.045	1.609	0.749	0.059		
			PERT. R/O (IN.)	0.04	1.57	0.72	0.05		
6-165			REF (R/F/R/O)	48	1.18	4.65	46.5		

TABLE 6-143A

SENSITIVITY ANALYSIS OF EPAET (50)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
RW12?	40	−20	Δ% OF R/O	+8.2	+3.5	+21.9	+46.7	+82.61	+11.17
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF = 23	F −0.410 W −0.175
			PERT. R/O (IN.)	0.10	2.25	0.63	0.17	SIM = 42	SP −1.095
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU −2.335
RW12?	60	+20	Δ% OF R/O	−6.1	−3.3	−16.1	−21.1	−39.1	−9.04
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF =23	F −0.305 W −0.165
			PERT. R/O (IN.)	0.09	2.10	0.44	0.09	SIM = 14	SP −0.805
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		WU −1.055

TABLE 6-143B

SENSITIVITY ANALYSIS OF MNRD (116)

SUBWATERSHED NO. 3 813 SQ. KM

ANNUAL R/F = 63.88 IN
EVAPOTRANSPIRATION NET = 37.42 IN
TOTAL OBSERVED ANNUAL R/O = 26.14 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	7/31/68 SUMMER	9/2/68 LOW FLOW	ANNUAL FLOW
125	93	−20	Δ% OF R/O	+1.7	+1.3	+5.1	+7.1	+13.0	+2.56
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF = 23	F − 0.085 W − 0.065
			PERT. R/O (IN.)	0.10	2.20	0.55	0.13	SIM = 26	SP − 0.255
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU − 0.355
124	131	+20	Δ% OF R/O	−1.1	−0.8	−3.1	−4.3	−8.7	− 1.64
			STORM R/F	2.51	3.11	1.70	2.21		STORM U/S
			REF. R/O (IN.)	0.095	2.170	0.521	0.117	REF =23	F − 0.055 W − 0.040
			PERT. R/O (IN.)	0.09	2.15	0.51	0.11	SIM = 21	SP − 0.155
6-166			REF (R/F/R/O)	26.4	1.43	3.26	18.9		WU − 0.215

TABLE 6-144A

SENSITIVITY ANALYSIS OF EPAET (37)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
RW123	29.6	−20	Δ% OF R/O	+5.4	+3.6	+13.6	+12.9	+125.0	+8.23
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 9	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.270 W −0.180
			PERT. R/O (IN.)	0.04	1.98	1.05	0.10		SP −0.680
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.645
RW122	44.4	+20	Δ% OF R/O	−4.8	−3.2	−11.8	−8.4	−25.0	−7.1
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 3	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F −0.240 W −0.160
			PERT. R/O (IN.)	0.03	1.85	0.81	0.08		SP −0.590
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.420

TABLE 6-144B

SENSITIVITY ANALYSIS OF MNRD (150)

SUBWATERSHED NO. 5 1,064 SQ. KM

ANNUAL R/F = 48.24 IN
EVAPOTRANSPIRATION NET = 27.87 IN
TOTAL OBSERVED ANNUAL R/O = 22.36 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/9/68 WINTER	4/25/68 SPRING	8/13/68 SUMMER	9/29/68 LOW FLOW	ANNUAL FLOW
125	120	−20	Δ% OF R/O	+1.4	+1.5	+3.8	+2.7	+25.0	+ 2.35
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 5	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F − 0.070 W − 0.075
			PERT. R/O (IN.)	0.04	1.94	0.96	0.09		SP − 0.190
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU − 0.135
124	180	+20	Δ% OF R/O	−1.4	−1.4	−3.6	−2.4	0.0	− 2.21
			STORM R/F	1.08	2.04	1.82	2.22	REF = 4 SIM = 4	STORM U/S
			REF. R/O (IN.)	0.036	1.907	0.921	0.086		F − 0.070 W − 0.070
			PERT. R/O (IN.)	0.04	1.88	0.89	−0.08		SP − 0.180
6-167			REF (R/F/R/O)	30	1.06	1.97	25.8		SU − 0.120

TABLE 6-145A

SENSITIVITY ANALYSIS OF EPAET (40)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
RW123	32	−20	Δ% OF R/O	+14.2	+4.9	+17.4	+99.2	+112.50	+13.11
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 85	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.710 W −0.245
			PERT. R/O (IN.)	0.03	1.63	0.72	0.25		SP −0.870
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU−4.960
RW122	48	+20	Δ% OF R/O	−9.9	−4.7	−15.0	−43.1	−47.5	−10.26
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 21	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.495 W −0.235
			PERT. R/O (IN.)	0.03	1.48	0.52	0.07		SP −0.750
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU−2.155

TABLE 6-145B

SENSITIVITY ANALYSIS OF MNRD (102)

SUBWATERSHED NO. 7 1,111 SQ. KM

ANNUAL R/F = 50.93 IN
EVAPOTRANSPIRATION NET = 33.02 IN
TOTAL OBSERVED ANNUAL R/O = 18.29 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/15/67 FALL	1/8/68 WINTER	4/26/68 SPRING	8/14/68 SUMMER	9/30/68 LOW FLOW	ANNUAL FLOW
125	82	−20	Δ% OF R/O	+1.9	+1.4	+4.1	+15.1	+17.5	+ 2.59
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 47	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F −0.095 W − 0.070
			PERT. R/O (IN.)	0.03	1.58	0.63	0.15		SP − 0.205
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU− 0.755
124	122	+20	Δ% OF R/O	−2.0	−1.4	−4.0	−12.2	−12.5	− 2.49
			STORM R/F	1.58	2.76	1.92	2.95	REF = 40 SIM = 35	STORM U/S
			REF. R/O (IN.)	0.029	1.557	0.610	0.127		F − 0.100 W − 0.070
			PERT. R/O (IN.)	0.03	1.53	0.59	0.11		SP − 0.200
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU− 0.610

TABLE 6-146A

SENSITIVITY ANALYSIS OF EPAET (30)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
RW123	24	−20	Δ% OF R/O	+2.1	+6.1	+20.2	+40.5	+244.4	+11.44
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 31	STORM U/S F −0.105 W −0.305 SP −1.010 SU −2.025
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.82	0.71	0.04		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
RW122	36	+20	Δ% OF R/O	−1.6	−5.7	−16.8	−16.5	−33.3	−8.86
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 6	STORM U/S F −0.080 W −0.285 SP −0.840 SU −0.825
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.73	0.49	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

TABLE 6-146B

SENSITIVITY ANALYSIS OF MNRD (115)

SUBWATERSHED NO. 11 2,551 SQ. KM

ANNUAL R/F = 35.81 IN
EVAPOTRANSPIRATION NET = 26.35 IN
TOTAL OBSERVED ANNUAL R/O = 12.82 IN

RUN ID	PARAM VALUE	Δ % PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/28/67 FALL	1/8/68 WINTER	5/8/68 SPRING	8/20/68 SUMMER	9/14/68 LOW FLOW	ANNUAL FLOW
125	92	−20	Δ% OF R/O	+0.4	+1.6	+4.6	+6.5	+77.8	+ 2.49
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 16	STORM U/S F − 0.020 W − 0.080 SP − 0.230 SU − 0.325
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.78	0.61	0.03		
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		
124	138	+20	Δ% OF R/O	−0.4	−1.6	−4.5	−4.9	−11.11	−2.40
			STORM R/F	1.35	1.37	1.91	0.50	REF = 9 SIM = 8	STORM U/S F − 0.020 W − 0.080 SP − 0.225 SU − 0.245
			REF. R/O (IN.)	0.150	0.769	0.588	0.031		
			PERT. R/O (IN.)	0.15	0.76	0.56	0.03		
6-169			REF (R/F/R/O)	9.0	1.8	3.24	16.1		

TABLE 6-147

SENSITIVITY ANALYSIS OF EPAET −20% PERTURBATION

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	—	1.94	25		SU
RUN ID RW 123			Δ% OF R/O	+6.1	+5.3	+18.3	+46.4	+170.19	+13.27
			Δ% OF MONTHLY R/O	OCT +3.39	JAN +6.85	APR +8.96	AUG +55.81	9/15/68	STORM U/S
REGIONAL (37)	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F −0.305 W −0.265
			PERT. R/O	0.10	1.03	0.57	0.09	SIM = 1740	SP .815
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU −2.320
RUN ID RW 123			Δ% OF R/O	+11.9	+6.5	+18.5	+96.9	+226.47	+14.61
			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1 (50)	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F −0.595 W −0.325
			PERT. R/O	0.05	1.71	0.89	0.12	SIM = 111	SP −0.925
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU −4.845
RUN ID RW 123			Δ% OF R/O	+8.2	+3.5	+21.9	+46.7	+82.61	+11.17
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3 (50)	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F −0.410 W −0.175
			PERT. R/O	0.10	2.25	0.63	0.17	SIM = 42	SP −1.095
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU −2.335
RUN ID RW 123			Δ% OF R/O	+5.4	+3.6	+13.6	+12.9	+125.0	+8.23
			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5 (37)	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F −0.270 W −0.180
			PERT. R/O	0.04	1.98	1.05	0.10	SIM = 9	SP −0.680
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU −0.645
RUN ID RW 123			Δ% OF R/O	+14.2	+4.9	+17.4	+99.2	+112.50	+13.11
			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7 (40)	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F −0.710 W −0.245
			PERT. R/O	0.03	1.63	0.72	0.25	SIM = 85	SP −0.870
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU −4.960
RUN ID RW 123			Δ% OF R/O	+2.1	+6.1	+20.2	+40.6	+244.4	+11.44
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11 (30)	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F −0.105 W −0.305
			PERT. R/O	0.16	0.82	0.71	0.04	SIM = 31	SP −1.010
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU −2.025

TABLE 6-148

SENSITIVITY ANALYSIS OF EPAET +20% PERTURBATION

SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/67 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	––	1.94	25		SU
RUN ID RW 122			Δ% OF R/O	–5.2	–4.9	–14.2	–20.0	–49.5	–10.03
			Δ% OF MONTHLY R/O	OCT –3.39	JAN –6.11	APR –8.46	AUG –22.48	9/15/68	STORM U/S F –0.260
REGIONAL	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	W –0.245
(37)			PERT. R/O	0.09	0.93	0.42	0.05	SIM = 325	SP –0.710
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU –1.000
RUN ID			Δ% OF R/O	–9.5	–5.9	–15.2	–45.4	–55.9	–11.43
RW 122			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
SUB-WATERSHED NO. 1	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F –0.475 W –0.295
(50)			PERT. R/O	0.04	1.51	0.64	0.03	SIM = 15	SP –0.760
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU –2.270
RUN ID RW 122			Δ% OF R/O	–6.1	–3.3	–16.1	–21.1	–39.1	–9.04
			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
SUB-WATERSHED NO. 3	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F –0.305 W –0.165
(50)			PERT. R/O	0.09	2.10	0.44	0.09	SIM = 14	SP –0.805
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU –1.055
RUN ID			Δ% OF R/O	–4.8	–3.2	–11.8	–8.4	–25.0	–7.1
RW 122			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
SUB-WATERSHED NO. 5	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F –0.240 W –0.160
(37)			PERT. R/O	0.03	1.85	0.81	0.08	SIM = 3	SP –0.590
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU –0.420
RUN ID			Δ% OF R/O	–9.9	–4.7	–15.0	–43.1	–47.5	–10.26
RW 122			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
SUB-WATERSHED NO. 7	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F –0.495 W –0.235
(40)			PERT. R/O	0.03	1.48	0.52	0.07	SIM = 21	SP –0.750
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU –2.155
RUN ID RW 122			Δ% OF R/O	–1.6	–5.7	–16.8	–16.5	–33.3	–8.86
			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
SUB-WATERSHED NO. 11	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F –0.080 W –0.285
(30)			PERT. R/O	0.15	0.73	0.49	0.03	SIM = 6	SP –0.840
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU –0.825

TABLE 6-149

SENSITIVITY ANALYSIS OF MNRD -20% PERTURBATION
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS FALL	WINTER	SPRING	SUMMER	LOW FLOW	ANNUAL FLOW
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F
			PERT. R/O					SIM =	W SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F
			PERT. R/O					SIM =	W SP
			REF (R/F/R/O)	91	--	1.94	25		SU
RUN ID RW 125			Δ% OF R/O	+1.4	+1.8	+4.1	+7.7	+26.1	+3.09
			Δ% OF MONTHLY R/O	OCT +0.56	JAN +1.95	APR +2.42	AUG +8.91	9/15/68	STORM U/S
REGIONAL (107)	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.070
			PERT. R/O	0.10	1.00	0.51	0.07	SIM = 812	W -0.090 SP -0.205
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.385
RUN ID RW 125			Δ% OF R/O	+2.6	+2.4	+4.6	+16.8	+35.3	+3.48
SUB-WATERSHED NO. 1			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
(128)	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.130
			PERT. R/O	0.05	1.65	0.78	0.07	SIM = 46	W -0.120 SP -0.230
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.840
RUN ID RW 125			Δ% OF R/O	+1.7	+1.3	+5.1	+7.1	+13.0	+2.55
SUB-WATERSHED NO. 3			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
(116)	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.085
			PERT. R/O	0.10	2.20	0.55	0.13	SIM = 26	W -0.065 SP -0.255
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.355
RUN ID RW 125			Δ% OF R/O	+1.4	+1.5	+3.8	+2.7	+25.0	+2.35
SUB-WATERSHED NO. 5			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
(150)	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.070
			PERT. R/O	0.04	1.94	0.96	0.09	SIM = 5	W -0.075 SP -0.190
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.135
RUN ID RW 125			Δ% OF R/O	+1.9	+1.4	+4.1	+15.1	+17.5	+2.59
SUB-WATERSHED NO. 7			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
(102)	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.095
			PERT. R/O	0.03	1.58	0.63	0.15	SIM = 47	W -0.070 SP -0.205
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.755
RUN ID RW 125			Δ% OF R/O	+0.4	+1.6	+4.6	+6.5	+77.8	+2.49
SUB-WATERSHED NO. 11			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
(115)	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.020
			PERT. R/O	0.15	0.78	0.61	0.03	SIM = 16	W -0.080 SP -0.230
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.325

TABLE 6-150

SENSITIVITY ANALYSIS OF MNRD +20% PERTURBATION
SMALL, SNOW & REGIONAL WATERSHEDS

WATERSHED	AREA (SQ. KM)	EPAET (IN)	OUTPUT	SIGNIFICANT STORMS				LOW FLOW	ANNUAL FLOW
				FALL	WINTER	SPRING	SUMMER		
RUN ID			Δ% OF R/O						
			STORM R/F	11/4/63 3.13	1/23/64 3.19	5/1/64 2.87	8/14/64 2.16	9/27/64	STORM U/S
SMALL	365	45	REF. R/O	0.175	2.31	1.94	0.255	REF = 7.9	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	17.9	1.38	1.47	8.3		SU
RUN ID			Δ% OF R/O						
			STORM R/F	10/18/57 2.99	4/21/58 0.0	5/10/58 1.78	8/13/58 1.09	9/7/58	STORM U/S
SNOW	277	32	REF. R/O	0.033	0.039	0.916	0.043	REF = 3.0	F W
			PERT. R/O					SIM =	SP
			REF (R/F/R/O)	91	——	1.94	25		SU
RUN ID RW 124			Δ% OF R/O	-1.3	-1.7	-3.9	-6.2	-17.4	-2.84
			Δ% OF MONTHLY R/O	OCT -1.13	JAN -1.87	APR -2.38	AUG -6.98	9/15/68	STORM U/S
REGIONAL (107)	22,248	41	REF. R/O	0.099	0.980	0.487	0.064	REF = 644	F -0.065 W -0.085
			PERT. R/O	0.10	0.96	0.47	0.06	SIM = 532	SP -0.195
			REF. MONTHLY R/O	0.177	3.634	2.600	0.258		SU -0.310
RUN ID RW 124			Δ% OF R/O	-2.5	-2.3	-4.3	-14.2	-26.5	-3.27
SUB- WATERSHED NO. 1 (128)			STORM R/F	10/15/67 2.16	1/8/68 1.91	4/26/68 3.49	8/18/68 2.79	9/25/68	STORM U/S
	2,326	50	REF. R/O	0.045	1.609	0.749	0.059	REF = 34	F -0.125 W -0.115
			PERT. R/O	0.04	1.57	0.72	0.05	SIM = 25	SP -0.215
			REF (R/F/R/O)	48	1.18	4.65	46.5		SU -0.710
RUN ID RW 124			Δ% OF R/O	-1.1	-0.8	-3.1	-4.3	-8.7	-1.64
SUB- WATERSHED NO. 3 (116)			STORM R/F	10/15/67 2.51	1/9/68 3.11	4/25/68 1.70	7/31/68 2.21	9/2/68	STORM U/S
	813	50	REF. R/O	0.095	2.170	0.521	0.117	REF = 23	F -0.055 W -0.040
			PERT. R/O	0.09	2.15	0.51	0.11	SIM = 21	SP -0.155
			REF (R/F/R/O)	26.4	1.43	3.26	18.9		SU -0.215
RUN ID RW 124			Δ% OF R/O	-1.4	-1.4	-3.6	-2.4	0.0	-2.21
SUB- WATERSHED NO. 5 (150)			STORM R/F	10/15/67 1.08	1/9/68 2.04	4/25/68 1.82	8/13/68 2.22	9/29/68	STORM U/S
	1,064	37	REF. R/O	0.036	1.907	0.921	0.086	REF = 4	F -0.070 W -0.070
			PERT. R/O	0.04	1.88	0.89	-0.08	SIM = 4	SP -0.180
			REF (R/F/R/O)	30	1.06	1.97	25.8		SU -0.120
RUN ID RW 124			Δ% OF R/O	-2.0	-1.4	-4.0	-12.2	-12.5	-2.49
SUB- WATERSHED NO. 7 (102)			STORM R/F	10/15/67 1.58	1/8/68 2.76	4/26/68 1.42	8/14/68 2.95	9/30/68	STORM U/S
	1,111	40	REF. R/O	0.029	1.557	0.610	0.127	REF = 40	F -0.100 W -0.070
			PERT. R/O	0.03	1.53	0.59	0.11	SIM = 35	SP -0.200
			REF (R/F/R/O)	54.5	1.77	3.14	23.2		SU -0.610
RUN ID RW 124			Δ% OF R/O	-0.4	-1.6	-4.5	-4.9	-11.11	-2.40
SUB- WATERSHED NO. 11 (115)			STORM R/F	10/28/67 1.35	1/8/68 1.37	5/8/68 1.91	8/20/68 0.50	9/14/68	STORM U/S
	2,551	30	REF. R/O	0.150	0.769	0.588	0.031	REF = 9	F -0.020 W -0.080
			PERT. R/O	0.15	0.76	0.56	0.03	SIM = 8	SP -0.225
			REF (R/F/R/O)	9.0	1.8	3.24	16.1		SU -0.245

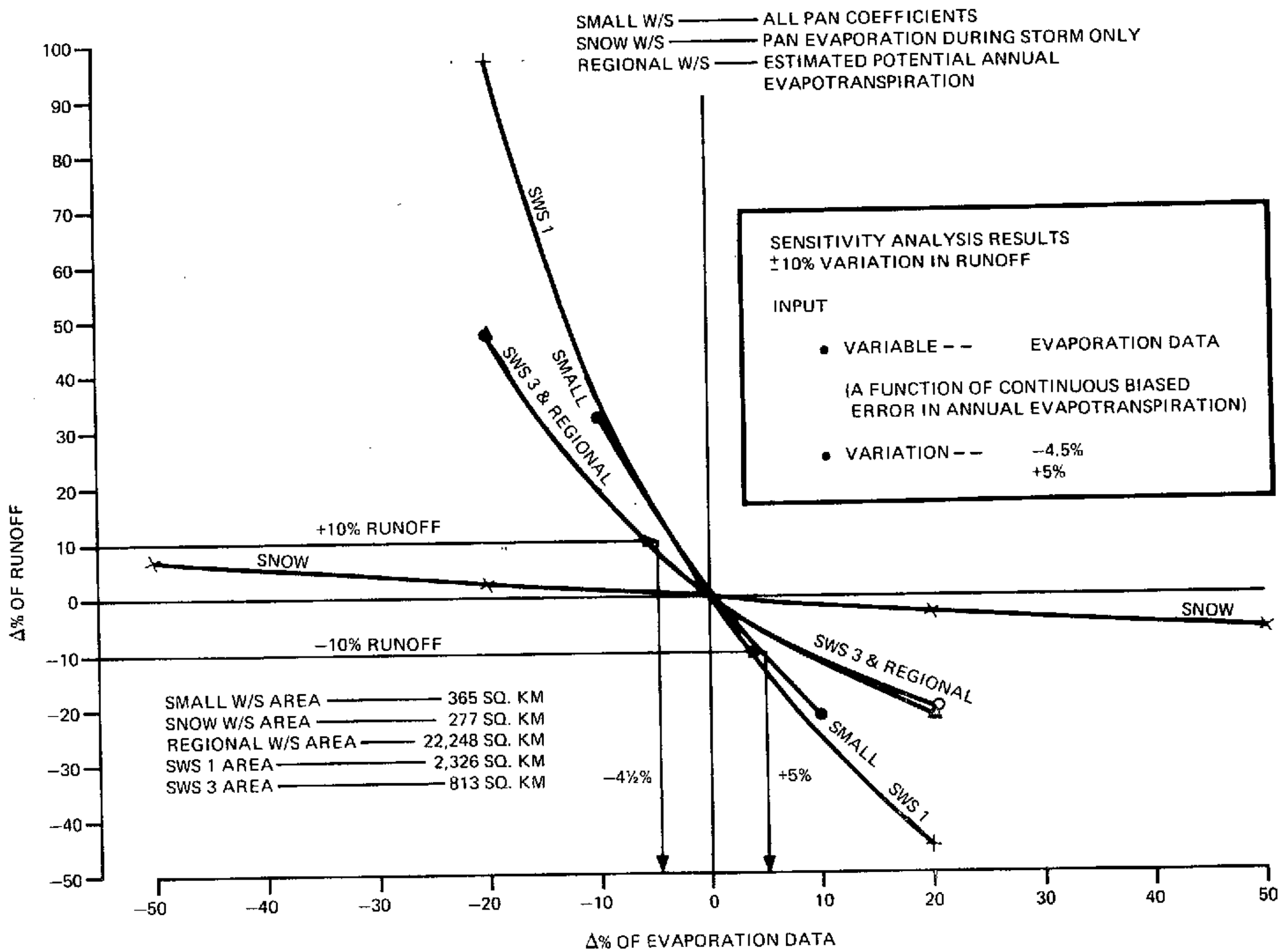


Figure 6-27. Evaporation Data Study, Summer Storms

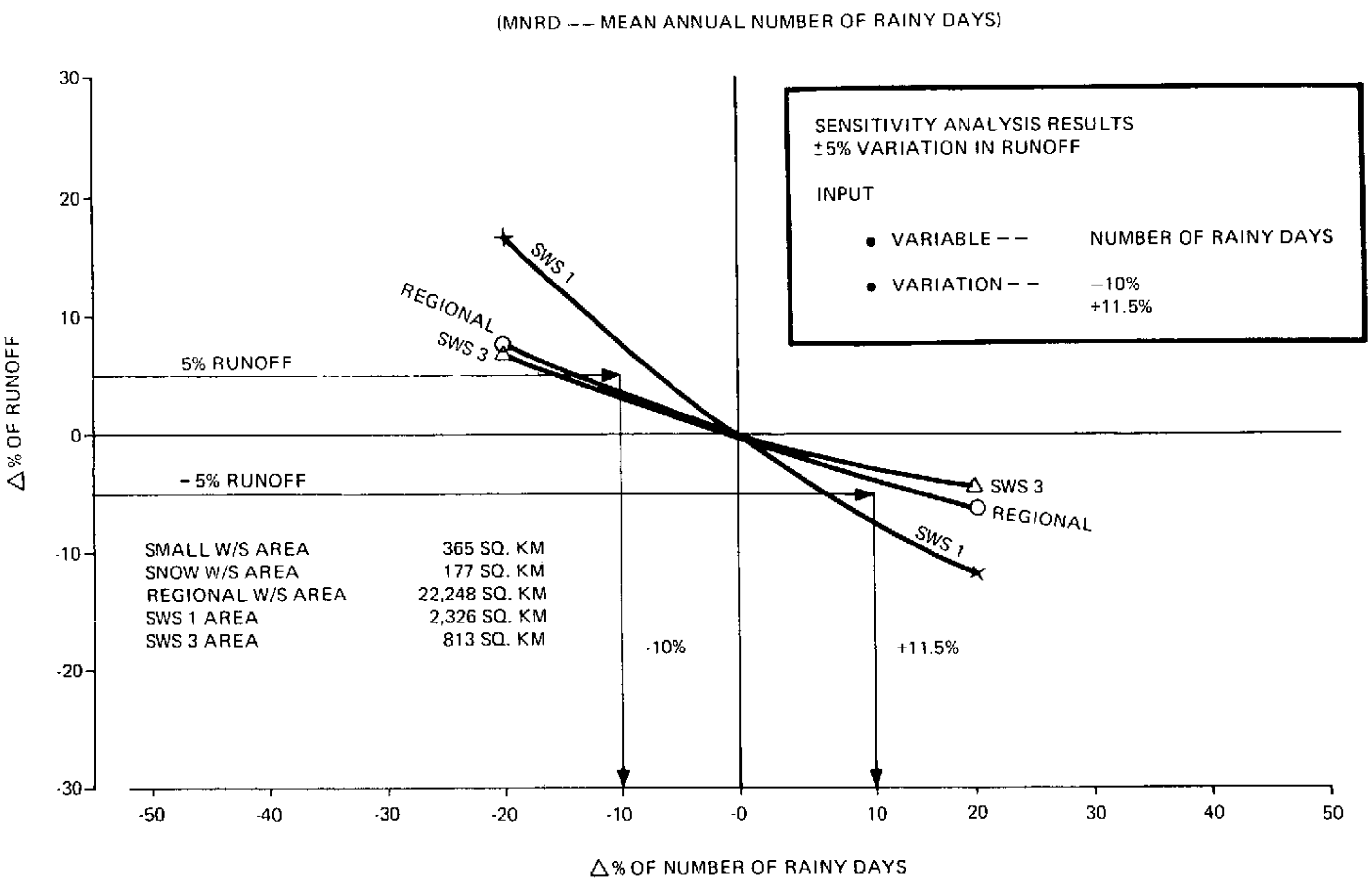


Figure 6-28. MNRD Study, Summer Storms

6.3.15 SENSITIVITY OF SMALL SNOWSHED MODEL TO CLIMATOLOGICAL INPUT PERTURBATIONS DURING STORMS

- Precipitation - Sensitivity analysis results indicate that the precipitation is sensitive during fall (October), spring (May), and summer (August) as was expected. The highest unit sensitivity occurs during spring at +0.90, and the low flows show +1.33. Hydrological consideration would suggest a unit sensitivity near unity.

- Evaporation - Sensitivity analysis shows the evaporation input data is most sensitive during April with a unit sensitivity of 0.40, and large sensitivity during low flows.

- Temperature - Daily maximum and minimum air temperature are required in the model if the snowmelt subroutine is called. These values are read in as an array of alternating maximum and minimum values for each day of the water year. Since air temperatures vary over a watershed, recorded temperatures from a station (preferably within the watershed) are adjusted by the main program to the mean elevation of the basin. Adjusted temperatures are then used for the remainder of the calculations involving temperature.

Sensitivity analysis results show that the temperature input data is very influential as was expected. It shows strong effects during April and May when the snow is melting. Results for all the seasons are presented in Table 6-151 and Figures 6-29 through 6-31.

TABLE 6-161

SENSITIVITY ANALYSIS OF STORM (PRECIP, EVAP, TEMP.)
SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
48 (PRECIP.)	—	-10	Δ% OF R/O	-5.5	-0.1	-8.6	-4.6	-13.33	-3.43
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.6	STORM U/S F +0.550 W +0.010 SP +0.860 SU +0.460
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0309	0.0393	0.8376	0.0412		
			REF (R/F/R/O)	91	—	1.94	25		
49 (PRECIP.)	—	+10	Δ% OF R/O	+5.6	+0.4	+9.2	+7.3	+20.0	+3.86
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.6	STORM U/S F +0.560 W +0.040 SP +0.920 SU +0.730
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0346	0.0395	1.0003	0.0464		
			REF (R/F/R/O)	91	—	1.94	25		
51A (EVAP.)	—	-20	Δ% OF R/O	+4.4	+8.8	+0.9	+2.7	+123.33	+1.74
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 6.7	STORM U/S F -0.220 W -0.440 SP -0.045 SU -0.135
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0342	0.0428	0.9245	0.0444		
			REF (R/F/R/O)	91	—	1.94	25		
52A (EVAP.)	—	+20	Δ% OF R/O	-4.3	-8.0	-0.9	-2.6	-30.0	-1.26
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.1	STORM U/S F -0.215 W -0.400 SP -0.045 SU -0.130
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0314	0.0362	0.9081	0.0421		
			REF (R/F/R/O)	91	—	1.94	25		
55A (TEMP.)	—	-10	Δ% OF R/O	-15.6	-28.4	-26.0	+11.4	+20.0	-0.24
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.6	STORM U/S F +1.560 W +2.840 SP +2.600 SU -1.140
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0276	0.0281	0.6777	0.0481		
			REF (R/F/R/O)	91	—	1.94	25		
56A (TEMP.)	—	+10	Δ% OF R/O	+0.8	+182.1	+37.0	-11.1	-23.33	+1.97
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.3	STORM U/S F +0.800 W +18.210 SP +3.700 SU -1.110
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0330	0.1109	1.2553	0.0384		
			REF (R/F/R/O)	91	—	1.94	25		

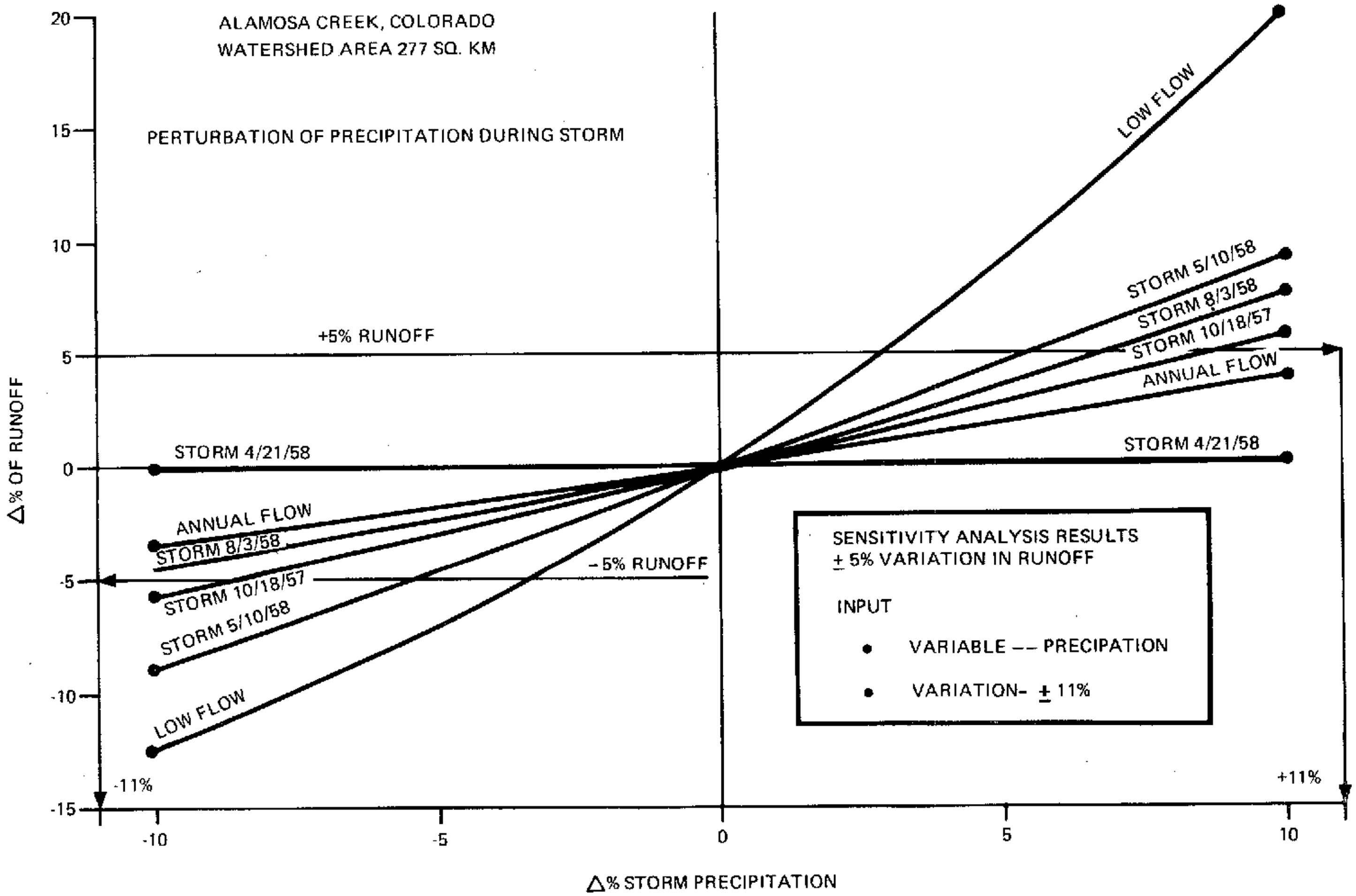


Figure 6-29. Storm Precipitation Study, Small Snowshed

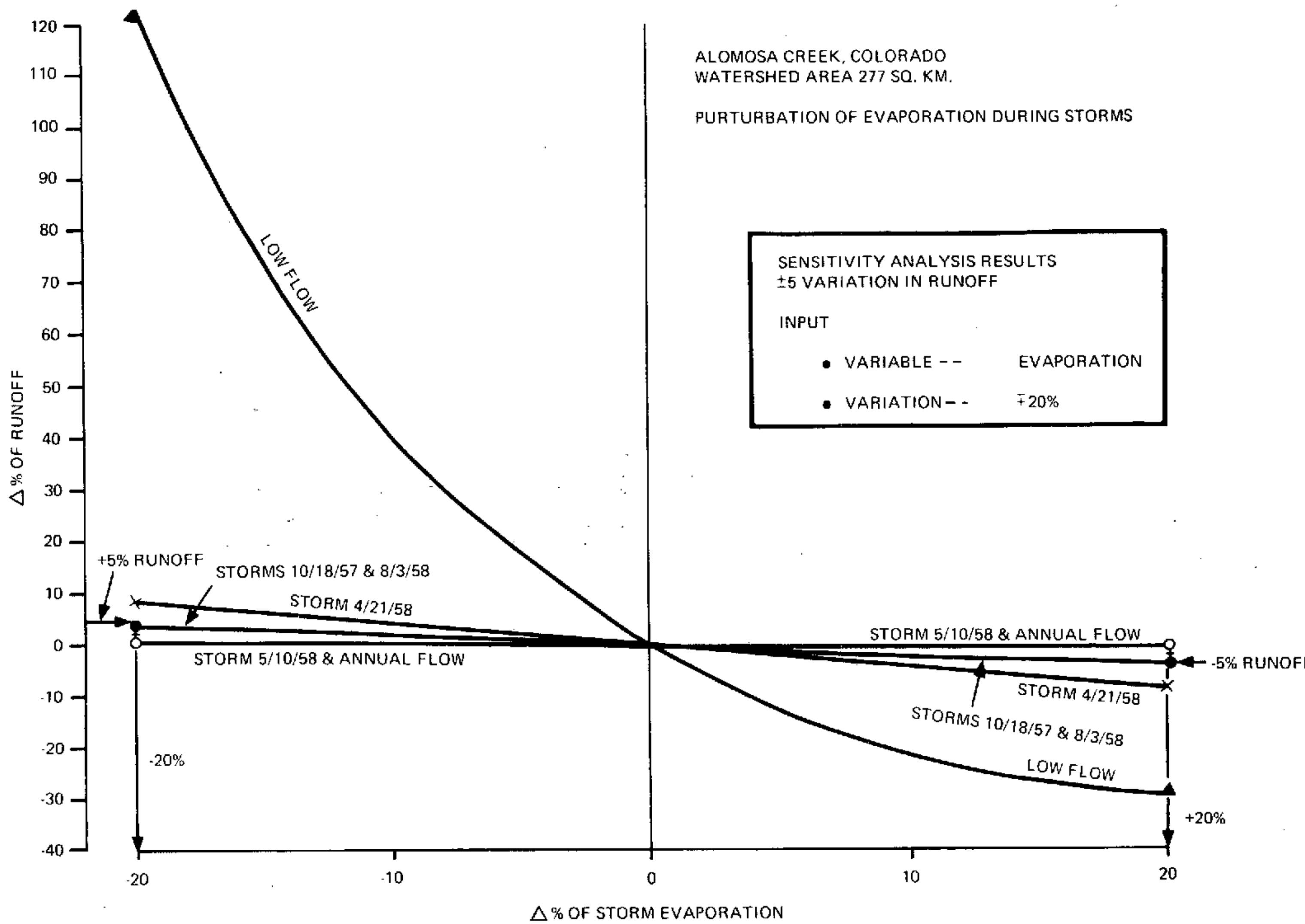


Figure 6-30. Storm Evaporation Study, Small Snowshed

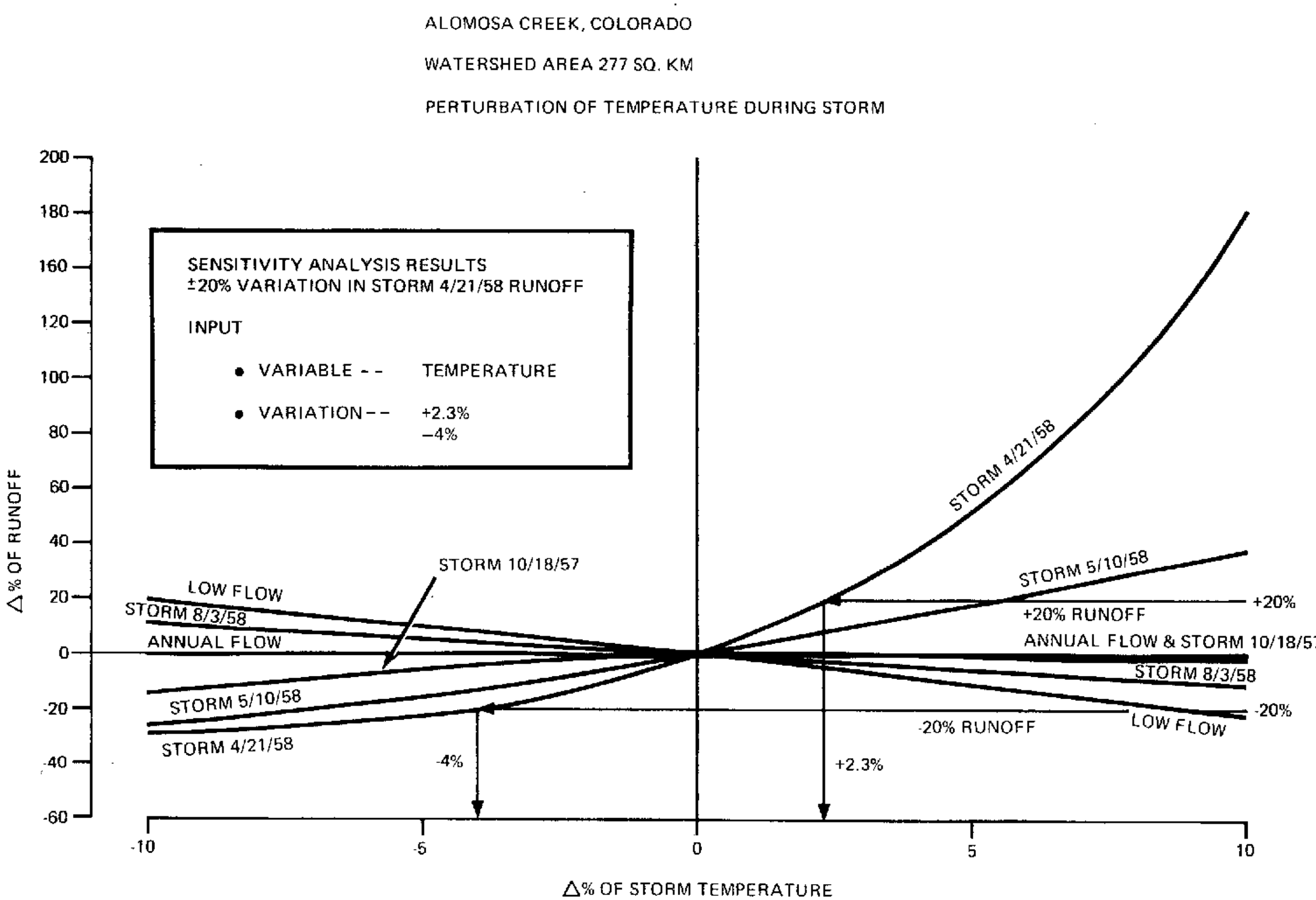


Figure 6-31. Storm Temperature Study, Small Snowshed

6.3.16 FIRR, FRACTION OF INCIDENT RADIATION REFLECTED BY SNOW

This is an array of 15 values which are used to adjust snowmelt rates as snow surface albedo changes. It is well known that snow surface albedos change with age and also with rainfall on the surface. Snow albedos have been shown to vary from a maximum of about 0.80 for new fallen snow to a minimum of about 0.40 for a ripe snowpack during the melt season. Under melting conditions, the albedo can change from the maximum to the minimum in about 15 days (Figure 6-32). This relationship is the basis for the FIRR array.

Results of the sensitivity analysis (Table 6-152) show that it is most influential during the snowmelt period. Results of all four seasons and annual and low flows are all plotted and presented in Figure 6-33. The average unit sensitivity is -1.48.

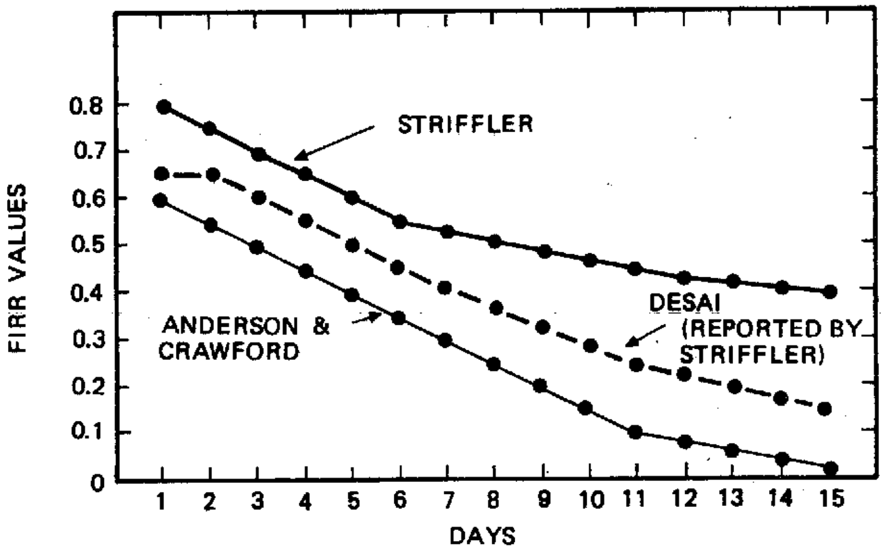


Figure 6-32. FIRR Array

TABLE 6-152

SENSITIVITY ANALYSIS OF FIRR (15)
SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
66		- 50	Δ% OF R/O	-0.1	+125.9	+24.6	-10.2	-23.33	+2.66
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.3	STORM U/S F +0.002 W -2.518 SP -0.492 SU +0.204
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0327	0.0888	1.1411	0.0388		
			REF (R/F/R/O)	91	—	1.94	25		
67		- 20	Δ% OF R/O	0.0	+36.8	+9.6	-4.1	-10.0	+1.13
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.7	STORM U/S F 0.0 W -1.840 SP -0.480 SU +0.205
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.0538	1.0044	0.0414		
			REF (R/F/R/O)	91	—	1.94	25		
68		+ 20	Δ% OF R/O	+0.1	-24.0	-9.4	+4.3	+10.0	-1.33
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.3	STORM U/S F +0.005 W -1.200 SP -0.470 SU +0.215
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.0299	0.8304	0.0451		
			REF (R/F/R/O)	91	—	1.94	25		
69		+ 50	Δ% OF R/O	+0.2	-29.2	-23.7	+12.1	+26.67	-3.41
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.8	STORM U/S F +0.004 W -0.584 SP -0.474 SU +0.242
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.0279	0.6995	0.0485		
6-182			REF (R/F/R/O)	91	—	1.94	25		

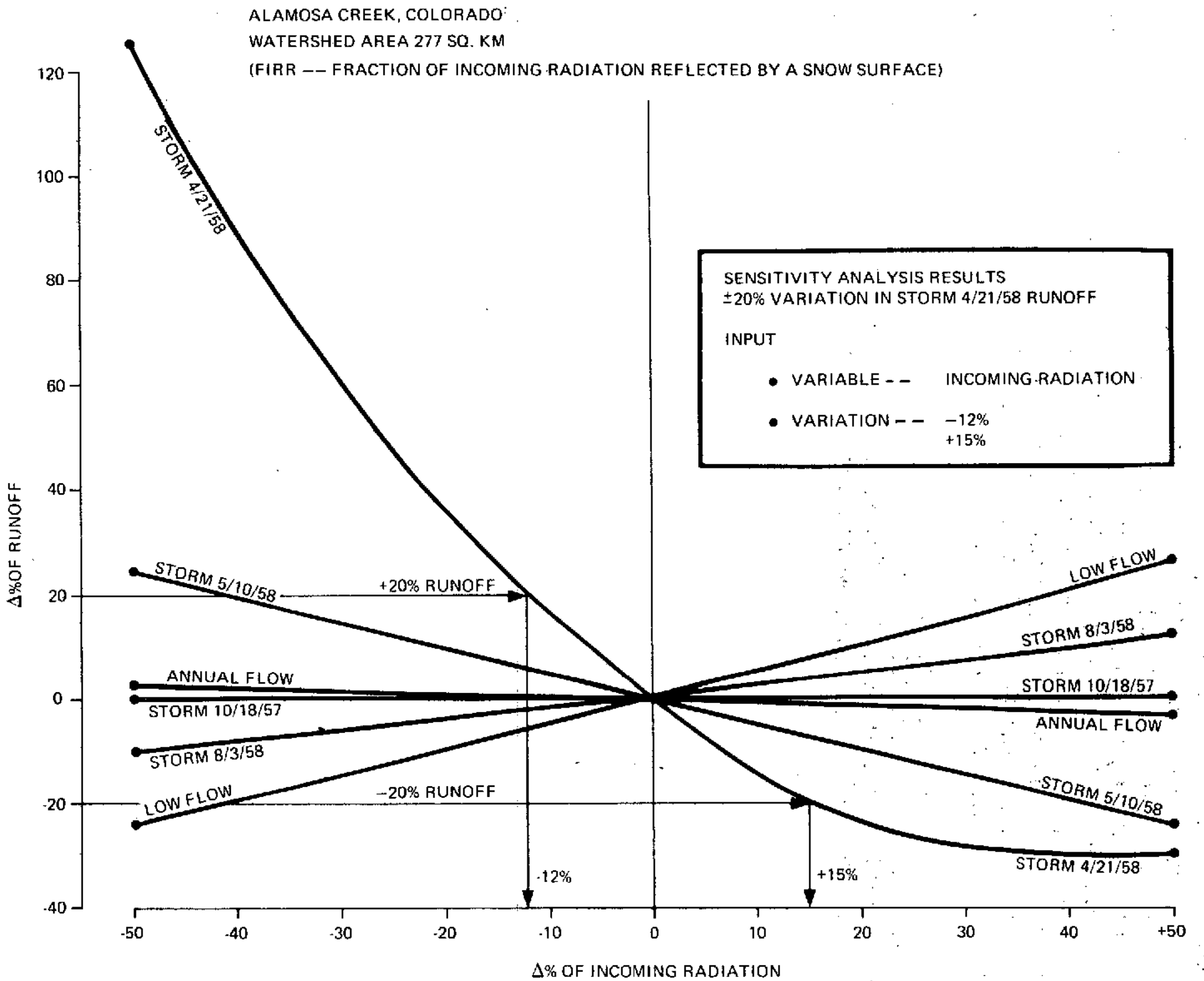


Figure 6-33. Incoming Radiation Study, Small Snowshed

6.3.17 BDDFSM, BASIC DEGREE DAY FACTOR FOR SNOWMELT

Although defined by Liou as a degree day melt factor, this parameter is actually a degree hour melt factor since the melt calculation is done hourly throughout the melt season. The parameter value represents the amount of melt which will occur in one hour for every degree F above a base temperature, usually 32°F, during the maximum melt rate season. The maximum melt rate calculated is reduced by several other factors since it is known that degree day melt factors are not uniform over a melt season. This parameter is important in determining the timing of snowmelt runoff and the height of peak runoff events during the snowmelt season. It is difficult to determine for any particular watershed. However, the values used by Anderson and Crawford ranged from .0035 to .0085. This parameter is usually optimized for a best fit.

Sensitivity analysis results indicate that it is very influential when perturbed at +10% and +20% during May. The unit sensitivities for those perturbations are +6.82 and +8.22, respectively (Table 6-153). Results of all four seasons are plotted and presented in Figure 6-34.

TABLE 6-153

SENSITIVITY ANALYSIS OF BDDFSM (0.0033)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
75	0.00264	-20	Δ% OF R/O	-0.3	-29.5	-29.4	+15.9	+36.67	-4.36
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 4.1	STORM U/S F +0.015 W +1.475 SP +1.470 SU -0.795
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.0277	0.6470	0.0501		
			REF (R/F/R/O)	91	---	1.94	25		
76	0.00297	-10	Δ% OF R/O	-0.1	-28.7	-14.8	+6.0	+13.33	-2.98
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.4	STORM U/S F +0.010 W +2.870 SP +1.480 SU -0.600
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0328	0.0280	0.7808	0.0458		
			REF (R/F/R/O)	91	---	1.94	25		
77	0.00363	+10	Δ% OF R/O	0.0	+68.2	+15.3	-7.3	-16.67	+1.04
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.5	STORM U/S F 0.0 W +6.820 SP +1.530 SU -0.730
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.0661	1.0566	0.0401		
			REF (R/F/R/O)	91	---	1.94	25		
78	0.00396	+20	Δ% OF R/O	-0.1	+164.4	+31.1	-11.9	-26.67	+3.88
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.2	STORM U/S F -0.005 W +8.220 SP +1.555 SU -0.595
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.033	0.1040	1.2015	0.0381		
			REF (R/F/R/O)	91	---	1.94	25		

6-185

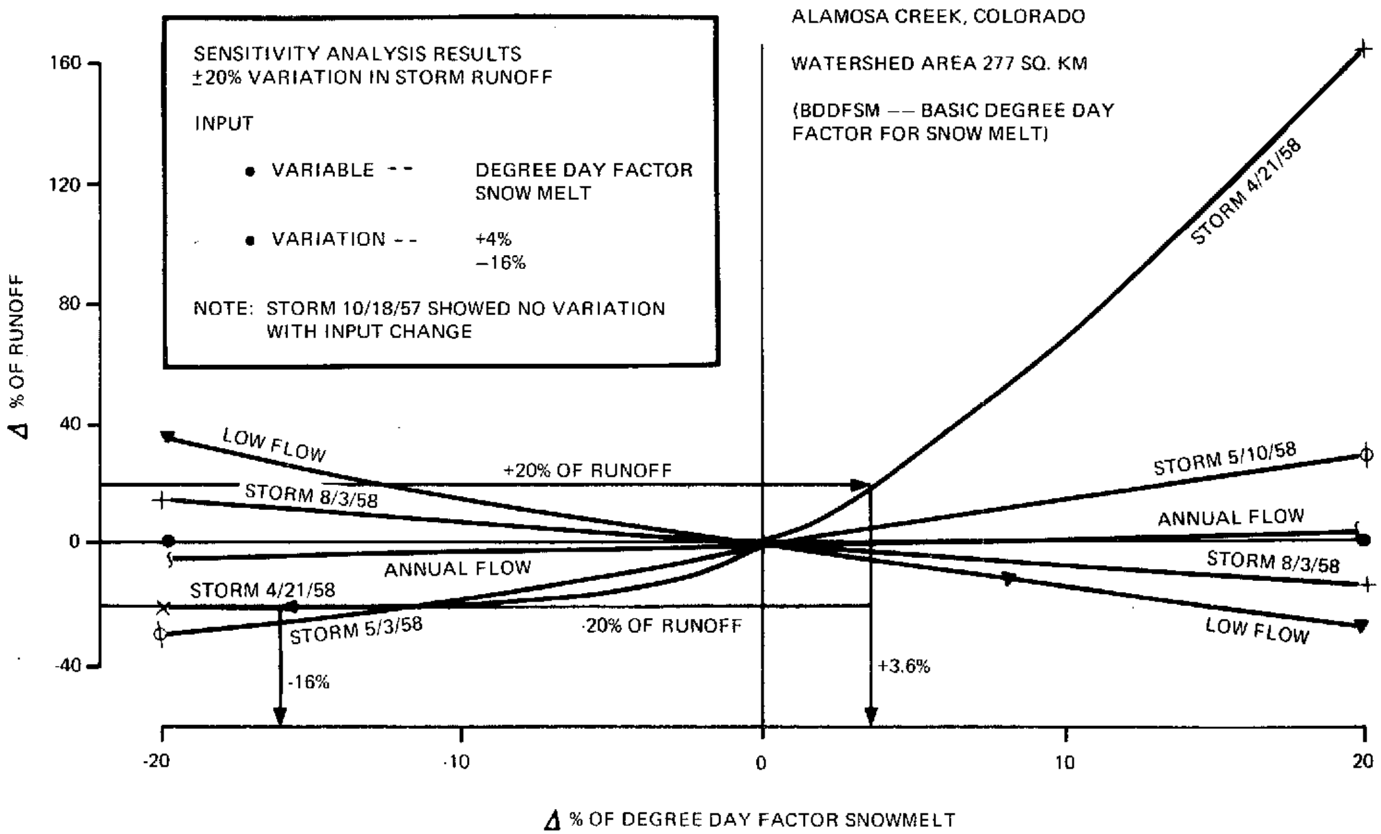


Figure 6-34. Degree Day Factor Study, Small Snowshed

6.3.18 SPBFLW, SNOWPACK BASIC MAXIMUM FRACTION IN LIQUID WATER

This parameter refers to the liquid water holding capacity of the snowpack expressed as a proportion of its total water content. Anderson and Crawford report literature values ranging from 4 to 7 percent depending on the density and other characteristics of the snowpack. This parameter is important in that it determines the timing of snowmelt runoff. In the snowmelt subroutine, no melt water will be released from the snowpack until water holding capacity has been filled. SPBFLW is generally estimated and optimized for a best fit value.

Results of sensitivity analysis (Table 6-154) show that it is most influential during May, and the average unit sensitivity to a ±50% perturbation is -0.74.

Results for all four seasons are plotted and presented in Figure 6-35.

SENSITIVITY ANALYSIS OF SPBFLW (0.040) AND SPTWCC (4.0)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
80 SPBFLW	0.02	-50	Δ% OF R/O	+3.1	+47.9	+1.2	-1.0	-3.33	+0.13
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 2.9	F -0.062
			PERT. R/O (IN.)	0.0338	0.0581	0.9268	0.0428		W -0.958
			REF (R/F/R/O)	91	—	1.94	25		SP -0.024 SU +0.020
81 SPBFLW	0.06	+50	Δ% OF R/O	-2.9	-25.9	-1.5	+0.9	0.0	-0.14
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F -0.058
			PERT. R/O (IN.)	0.0318	0.0291	0.9025	0.0436		W -0.518
			REF (R/F/R/O)	91	—	1.94	25		SP -0.030 SU +0.018
			Δ% OF R/O						
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM =	F
			PERT. R/O (IN.)						W
			REF (R/F/R/O)	91	—	1.94	25		SP SU
82 SPTWCC	2.0	-50	Δ% OF R/O	0.0	+2.1	+0.8	+6.7	3.33	+7.95
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.1	F 0.0
			PERT. R/O (IN.)	0.033	0.0401	0.9238	0.0461		W -0.042
			REF (R/F/R/O)	91	—	1.94	25		SP -0.016 SU -0.134
83 SPTWCC	6.0	+50	Δ% OF R/O	0.0	0.0	0.0	-7.2	-3.33	-7.97
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 2.9	F 0.0
			PERT. R/O (IN.)	0.033	0.039	0.916	0.0401		W 0.0
			REF (R/F/R/O)	91	—	1.94	25		SP 0.0 SU -0.144
			Δ% OF R/O						
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM =	F
			PERT. R/O (IN.)						W
			REF (R/F/R/O)	91	—	1.94	25		SP SU

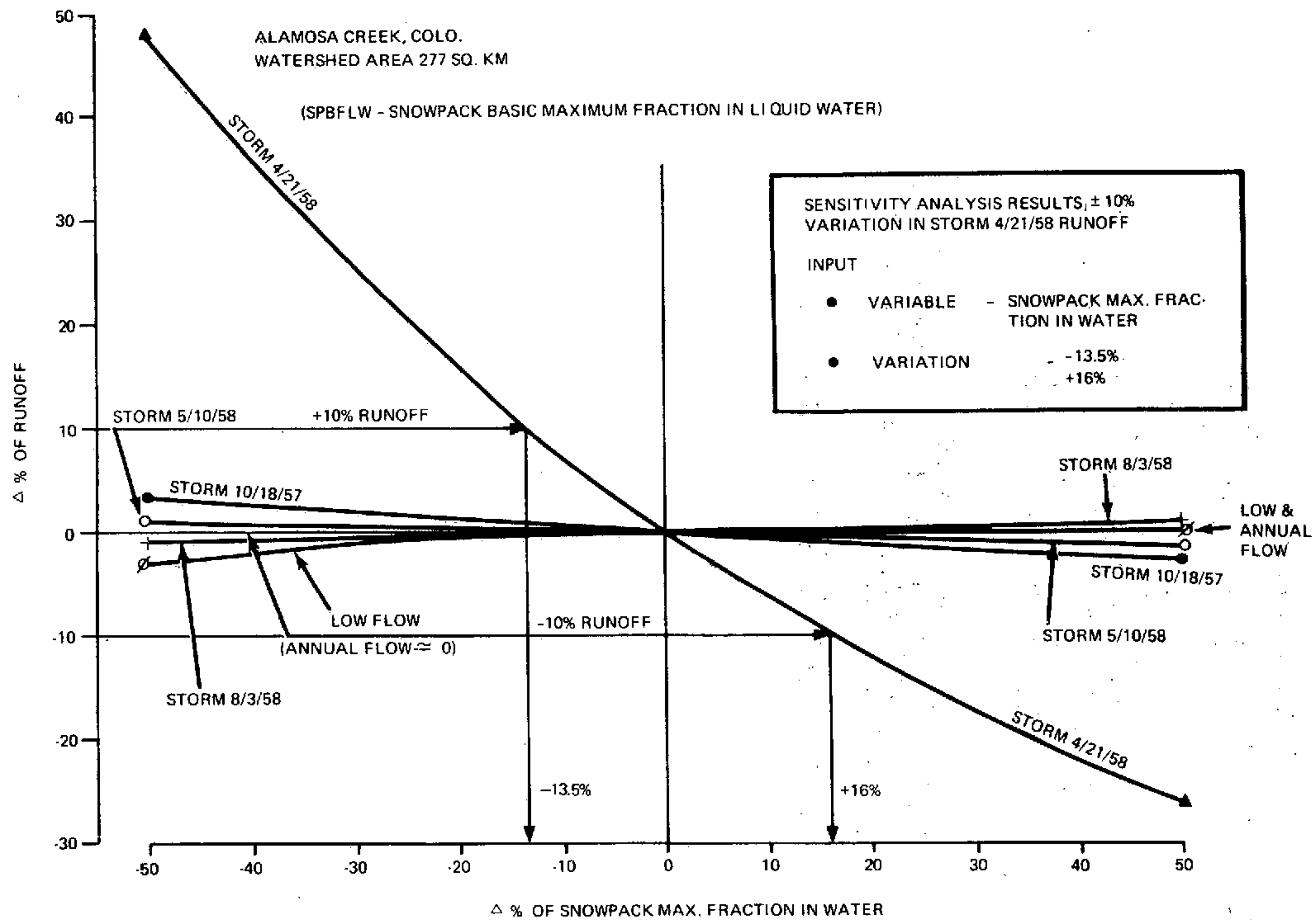


Figure 6-35. Snowpack Liquid Water Fraction Study

6.3.19 SPTWCC, SNOWPACK MINIMUM TOTAL WATER CONTENT FOR COMPLETE BASIN COVERAGE

In mountain watersheds with large elevation differences, considerable snow accumulation can take place on the upper watershed before the entire watershed is covered. This parameter attempts to define the water content at the point the entire basin becomes covered with snow. The parameter is used to adjust snowmelt for incomplete snow cover on the basin. When the water equivalent is less than the parameter index value, it is assumed that the snow covered area is proportionately less and melt is adjusted accordingly. This parameter is generally estimated and optimized for a best fit. A knowledge of snowpack water contents and accumulation patterns on the watershed is essential to assign a realistic value to the parameter.

Results of sensitivity analysis (Table 6-155) show that it is not an influential parameter. It shows some sensitivity during the summer season, and the annual flow. The unit sensivity for ±50% perturbation during summer is -0.14.

Results for all four seasons are plotted and presented in Figure 6-36.

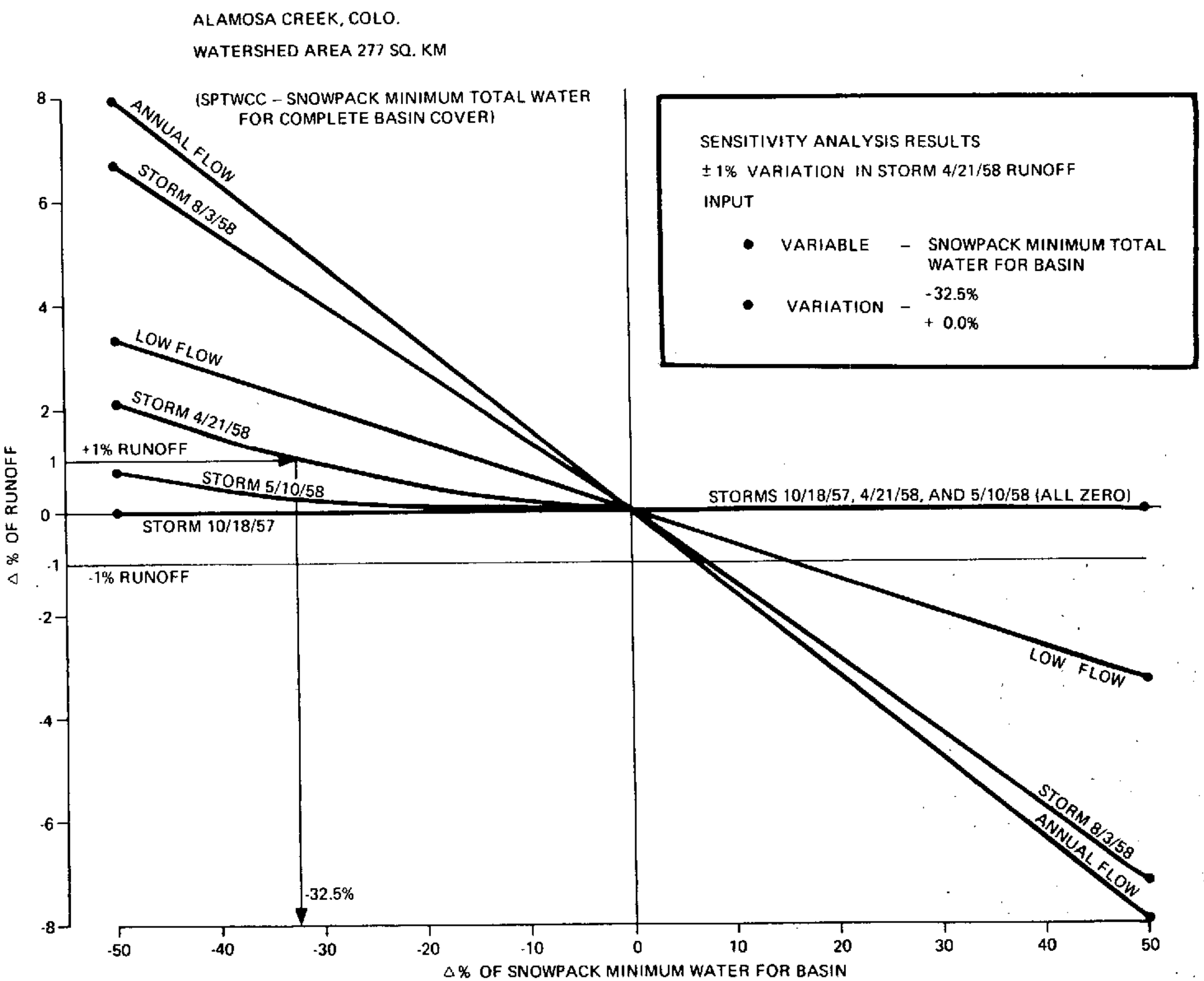


Figure 6-36. Snowpack Minimum Total Water Study

6.3.20 ELDIF, ELEVATION DIFFERENCE BETWEEN THE BASE THEROMETER AND THE MEAN BASIN ELEVATION

This parameter provides an elevation adjustment for temperature data. Since temperature stations on mountain watersheds are generally located at more accessible sites, usually low on the watershed, a temperature adjustment to estimate mean basin temperature from measured station temperature is required. The parameter, expressed in thousands of feet, is easily determined from a topographic map of the watershed. The parameter is positive if the station is below the mean basin elevation. It is obtainable from topographic maps.

Sensitivity analysis results (Table 6-156) indicate that it is very influential when perturbed -20% and -50% during May. The unit sensitivities for those perturbations are -2.75 and -4.67, respectively. Results for all four seasons are plotted and presented in Figure 6-37.

TABLE 6-156

SENSITIVITY ANALYSIS OF ELDIF (1.113)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
86	0.5565	-50	Δ% OF R/O	-1.7	+233.7	+35.5	–16.4	-30.0	+1.96
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.1	STORM U/S F +0.034 W -4.674 SP -0.710 SU +0.328
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0322	0.1312	1.2418	0.0361		
			REF (R/F/R/O)	91	––	1.94	25		
87	0.8904	-20	Δ% OF R/O	-2.6	+55.0	+11.5	-5.1	-10.0	+0.42
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.7	STORM U/S F +0.130 W -2.750 SP -0.575 SU +0.255
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0319	0.0609	1.0217	0.0410		
			REF (R/F/R/O)	91	––	1.94	25		
88	1.3356	+20	Δ% OF R/O	-0.4	-27.8	-12.8	+5.7	+10.0	-1.0
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.3	STORM U/S F -0.020 W -1.390 SP -0.640 SU +0.285
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0326	0.0284	0.7987	0.0457		
			REF (R/F/R/O)	91	––	1.94	25		
89	1.6695	+50	Δ% OF R/O	+21.7	+25.8	-25.4	+12.0	+23.33	-1.69
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.7	STORM U/S F +0.434 W +0.516 SP -0.508 SU +0.240
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0398	0.0292	0.6838	0.0484		
6-193			REF (R/F/R/O)	91	––	1.94	25		

ALAMOSA CREEK, COLORADO
WATERSHED AREA 277 SQ. KM

(ELDIF — ELEVATION DIFFERENCE BETWEEN BASE TEMPERATURE STATION AND MEAN BASIN EVEVATION)

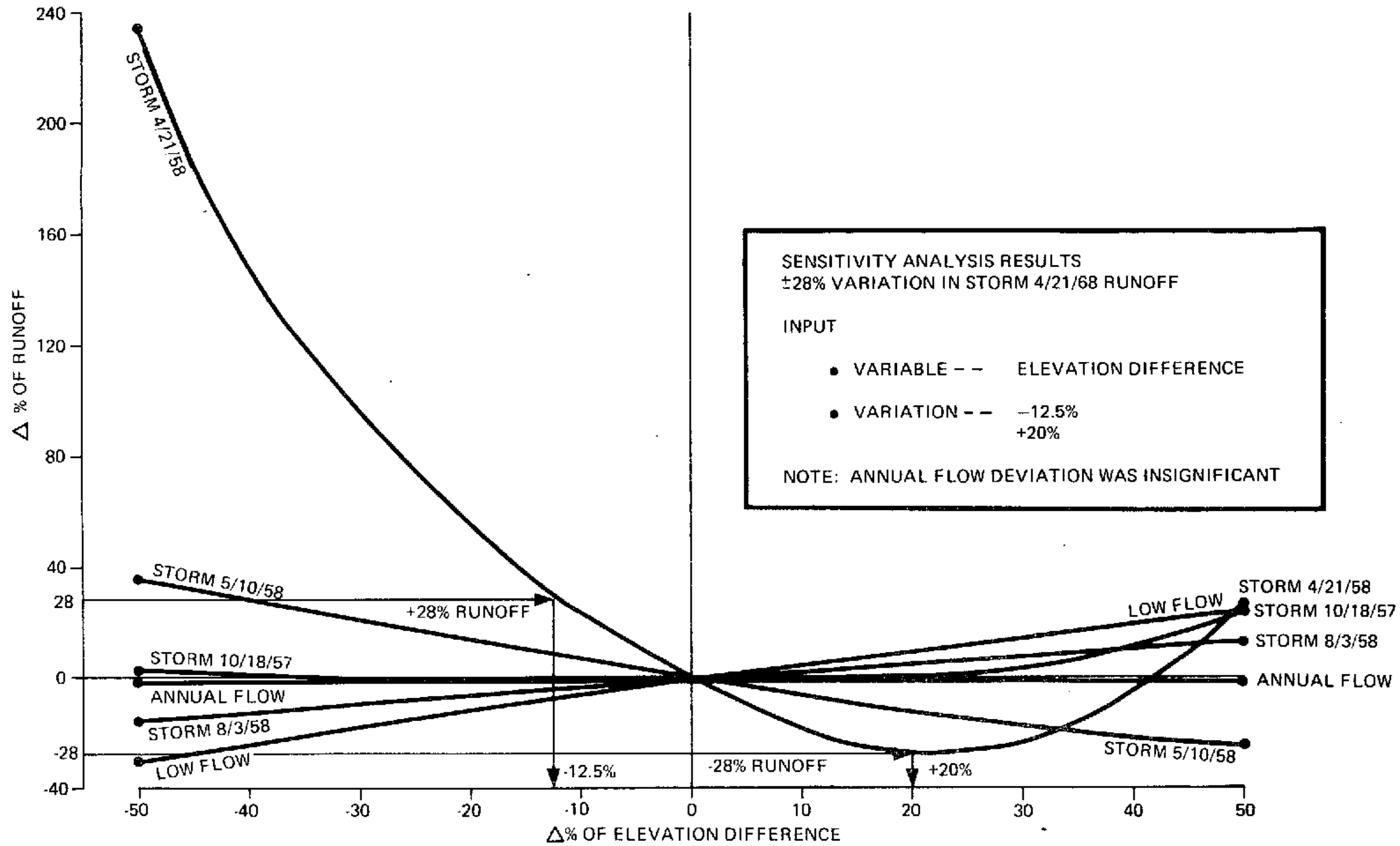


Figure 6-37. Elevation Difference Study, Small Snowshed

6.3.21 FFOR, FRACTION OF THE WATERSHED FORESTED

This parameter is defined as the area of forest cover times the average cover density. Thus, a knowledge of the proportion of forest cover plus the average density of the forest is required to estimate this parameter. The proportion of forest cover on a watershed can easily be determined from cover type maps or aerial photographs. For larger watersheds, satisfactory estimates can be obtained from the USGS topographic quadrangle maps with the green forest cover overprint. An estimate of the average canopy density on the watershed is more difficult, although satisfactory estimates can be obtained from cover type maps and aerial photographs. This parameter is important in that it determines snow interception losses and snowmelt adjustments due to reflected radiation. It can be directly obtained from land-use classification in remotely-sensed image analysis.

This parameter is influential during winter, spring, summer, low flows and annual flows. Only during an October storm has it shown no significant influence.

The results of all four seasons, the low flows, and the annual flow appear in Table 6-157 and in Figure 6-38.

TABLE 6-157

SENSITIVITY ANALYSIS OF FFOR (0.40)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
94	0.20	-50	Δ% OF R/O	-0.3	-15.5	+9.1	+14.9	+30.0	+10.48
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F +0.006
			PERT. R/O (IN.)	0.0327	0.0332	0.9996	0.0497	SIM = 3.9	W +0.310 SP -0.182
			REF (R/F/R/O)	91	---	1.94	25		SU -0.298
95	0.32	-20	Δ% OF R/O	-0.1	-10.6	+2.6	+6.1	+10.0	+4.55
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F +0.005
			PERT. R/O (IN.)	0.0327	0.0351	0.9401	0.0459	SIM = 3.3	W +0.530 SP -0.130
			REF (R/F/R/O)	91	---	1.94	25		SU -0.305
96	0.48	+20	Δ% OF R/O	+0.1	+4.5	-1.6	-5.4	-10.0	-4.08
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F +0.005
			PERT. R/O (IN.)	0.0328	0.0411	0.9015	0.0409	SIM = 2.7	W +0.225 SP -0.080
			REF (R/F/R/O)	91	---	1.94	25		SU -0.270
97	0.60	+50	Δ% OF R/O	+0.3	+22.0	-2.3	-13.9	-26.67	-9.80
			STORM R/F	2.99	0.0	1.78	1.09		STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	REF = 3.0	F +0.006
			PERT. R/O (IN.)	0.0329	0.0480	0.8950	0.0372	SIM = 2.2	W +0.440 SP -0.046
6-196			REF (R/F/R/O)	91	---	1.94	25		SU -0.278

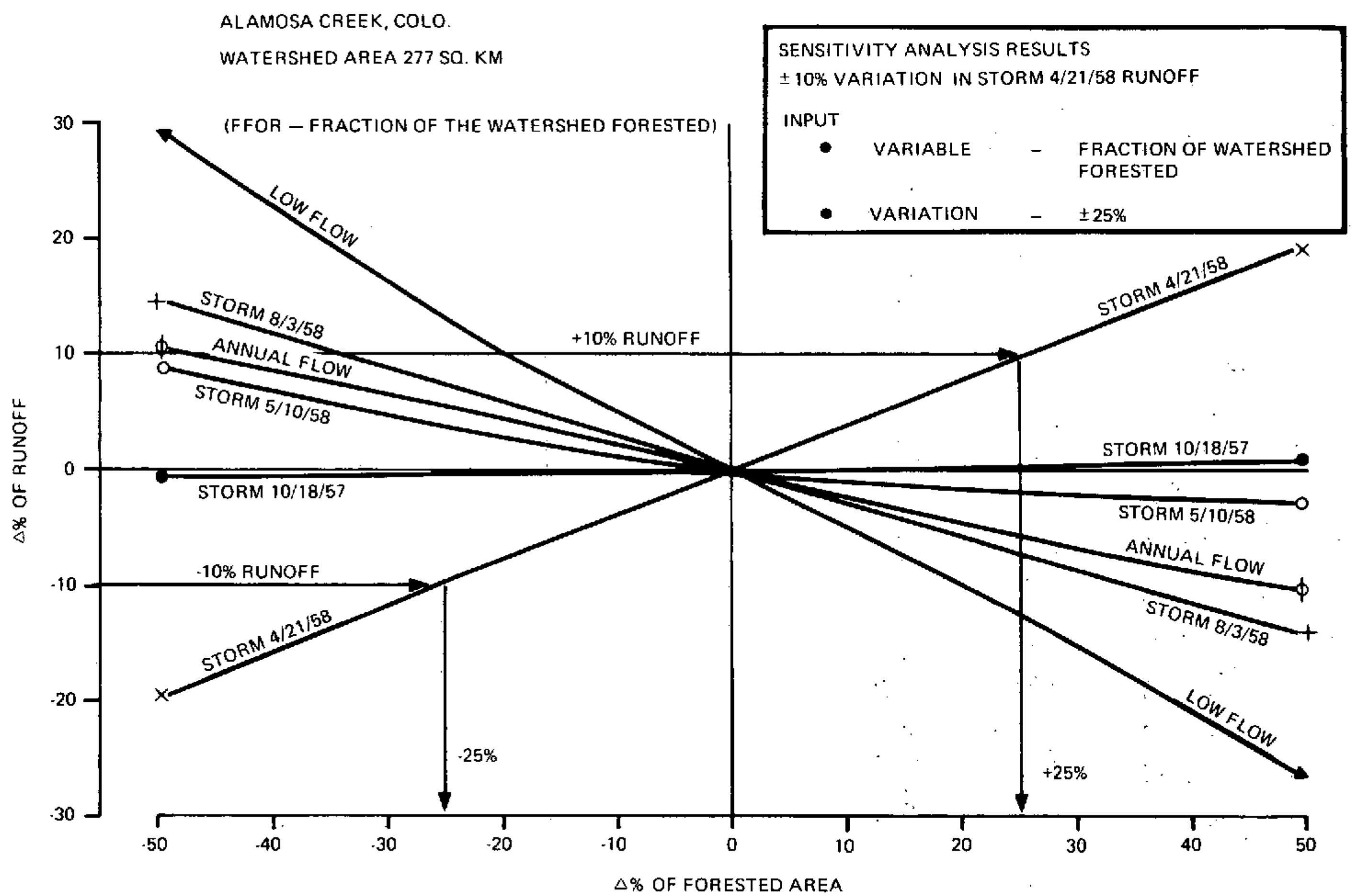


Figure 6-38. Forested Area Study, Small Snowshed

6.3.22 FRACTION OF SNOW INTERCEPTED

This parameter is defined as the proportion of snow which would be intercepted by a forest canopy if the cover density were 100%. This assumes that the amount of snow intercepted is a linear function of the total snowfall. This may be true to a point but for very large snowfalls or snowfall events accompanied by strong winds, the assumption does not hold. Leaf and Brink calculated snow interception for spruce-fir and lodgepole pine forests as 0.15 and 0.10, respectively of the snowfall for canopy densities up to a maximum of 0.30 and 0.20. Anderson and Crawford use a value of 0.15 for a sub-alpine watershed in the Sierras.

This parameter shows some influence during storms in May and August. The unit sensitivity to a -50% perturbation is +0.16 in May and -0.12 in August. Note that the polarity of unit sensitivity from May to August changes.

Results of all seasons, low and annual flows, appear in Table 6-158 and Figure 6-39.

TABLE 6-158

SENSITIVITY ANALYSIS OF FFSI (0.15)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
102	0.075	-50	Δ% OF R/O	-0.4	-7.9	-0.6	+6.8	+10.0	+3.93
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.3	STORM U/S F +0.008 W +0.158 SP +0.012 SU -0.116
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0326	0.0362	0.9108	0.0457		
			REF (R/F/R/O)	91	--	1.94	25		
103	0.120	-20	Δ% OF R/O	-0.2	-1.5	-0.1	+2.4	+3.33	+1.72
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 3.1	STORM U/S F +0.010 W +0.075 SP +0.005 SU -0.120
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0327	0.0387	0.9149	0.0442		
			REF (R/F/R/O)	91	--	1.94	25		
104	0.180	+20	Δ% OF R/O	+0.2	+1.1	+0.1	-2.1	-6.67	-1.50
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.8	STORM U/S F +0.010 W +0.055 SP +0.005 SU -0.105
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0328	0.0398	0.9174	0.0423		
			REF (R/F/R/O)	91	--	1.94	25		
105	0.225	+50	Δ% OF R/O	+0.4	+4.2	+0.5	-6.5	-13.33	-4.97
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0 SIM = 2.6	STORM U/S F +0.008 W +0.084 SP +0.010 SU +0.130
			REF. R/O (IN.)	0.033	0.039	0.916	0.043		
			PERT. R/O (IN.)	0.0329	0.0410	0.9206	0.0404		
6-199			REF (R/F/R/O)	91	--	1.94	25		

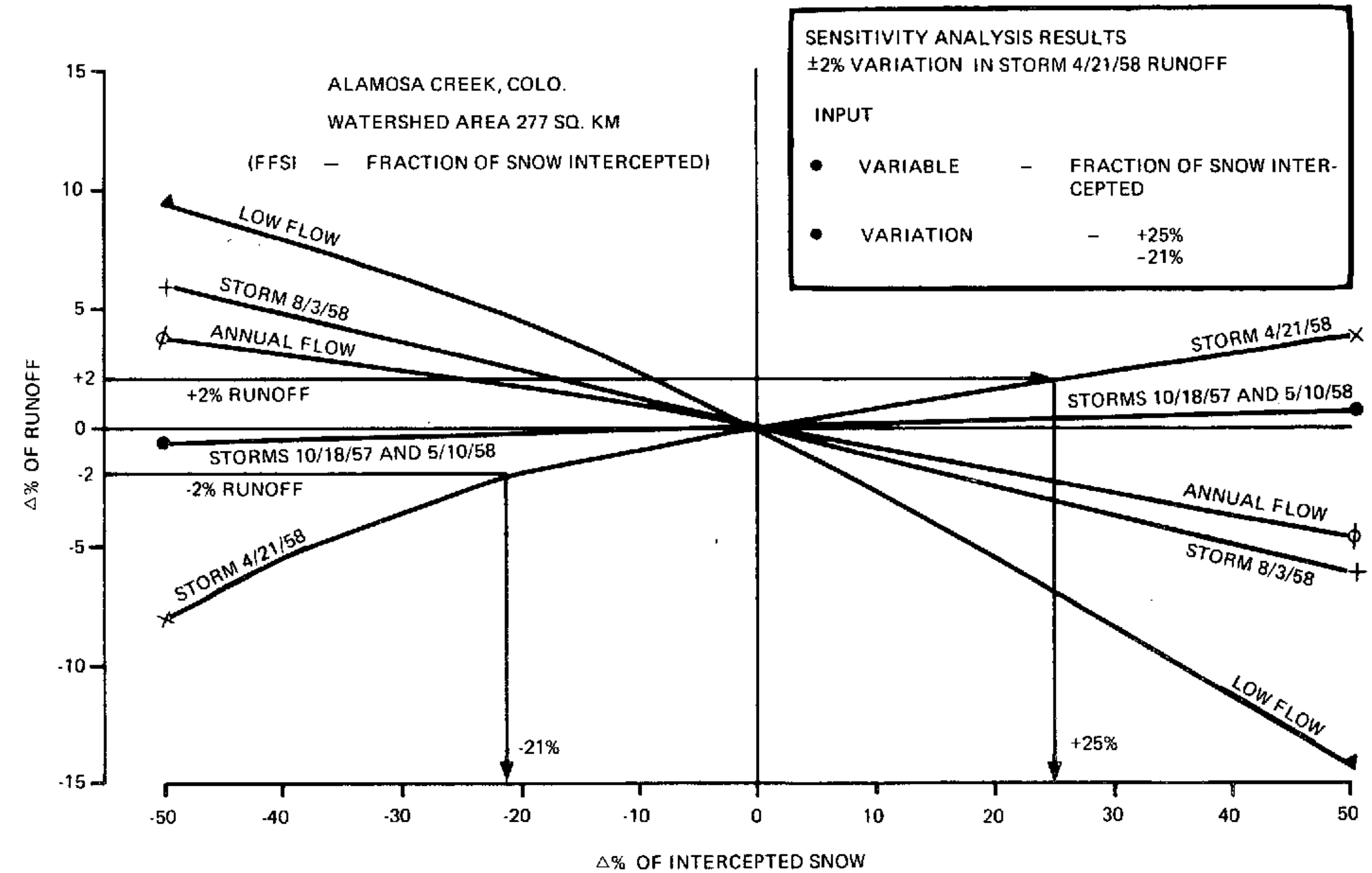


Figure 6-39. Intercepted Snow Study

6.3.23 PXCSA, PRECIPITATION INDEX FOR CHANGING SNOW ALBEDO

In the snowmelt subroutine the maximum snowmelt rate as determined by the basic degree hour factor is adjusted for shortwave radiation inputs and changes in the albedo of the snowpack. Various processes will affect the albedo of the snowpack including aging and the deposition of fresh snow or rain on the pack. The deposition of fresh snow deposit on the snowpack will increase the albedo while a rain on a snowpack will decrease the albedo. In the accounting procedure, the snowmelt adjustment factor (FIRR) is increased or decreased whenever an index value of new snow or rain is reached. The parameter, PXCSA, represents the index value for determining when changes in the albedo occur. Since the parameter is empirical and does not necessarily represent actual conditions, it is best determined by estimating and optimizing for a best fit. Anderson and Crawford used an index of 0.2 inches.

Results of sensivity analysis indicate that the parameter PXCSA is influential when it is reduced from its normal value during the May storm. It has not effect during fall and low flows.

The unit sensitivity to a -20% perturbation in May is +0.93.

Results appear in Table 6-159 and Figure 6-40.

TABLE 6-159

SENSITIVITY ANALYSIS OF PXCSA (0.199)

SNOW WATERSHED 277 SQ. KM

ANNUAL R/F = 33.38 IN
EVAPOTRANSPIRATION NET = 18.79 IN
TOTAL OBSERVED ANNUAL R/O = 10.03 IN

RUN ID	PARAM VALUE	Δ% PERTUR-BATION	OUTPUT	SIGNIFICANT STORMS 10/18/57 FALL	4/21/58 WINTER	5/10/58 SPRING	8/3/58 SUMMER	9/7/58 LOW FLOW	ANNUAL FLOW
114	0.0995	-50	Δ% OF R/O	0.0	-27.7	-3.3	+1.5	0.0	-0.27
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F 0.0
			PERT. R/O (IN.)	0.0327	0.0284	0.8860	0.0439		W +0.0554
			REF (R/F/R/O)	91	––	1.94	25		SP +0.066
									SU -0.030
115	0.1592	-20	Δ% OF R/O	0.0	-18.5	-1.4	+0.8	0.0	-0.01
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F 0.0
			PERT. R/O (IN.)	0.0327	0.0320	0.9034	0.0436		W +0.925
			REF (R/F/R/O)	91	––	1.94	25		SP +0.070
									SU -0.040
116	0.2388	+20	Δ% OF R/O	0.0	+1.9	+0.2	-0.1	0.0	+0.03
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F 0.0
			PERT. R/O (IN.)	0.0327	0.0401	0.9179	0.0432		W +0.095
			REF (R/F/R/O)	91	––	1.94	25		SP +0.010
									SU -0.005
117	0.2985	+50	Δ% OF R/O	0.0	+2.4	+0.2	-0.1	0.0	+0.03
			STORM R/F	2.99	0.0	1.78	1.09	REF = 3.0	STORM U/S
			REF. R/O (IN.)	0.033	0.039	0.916	0.043	SIM = 3.0	F 0.0
			PERT. R/O (IN.)	0.0327	0.0403	0.9183	0.0432		W +0.048
6-202			REF (R/F/R/O)	91	––	1.94	25		SP +0.004
									SU -0.002

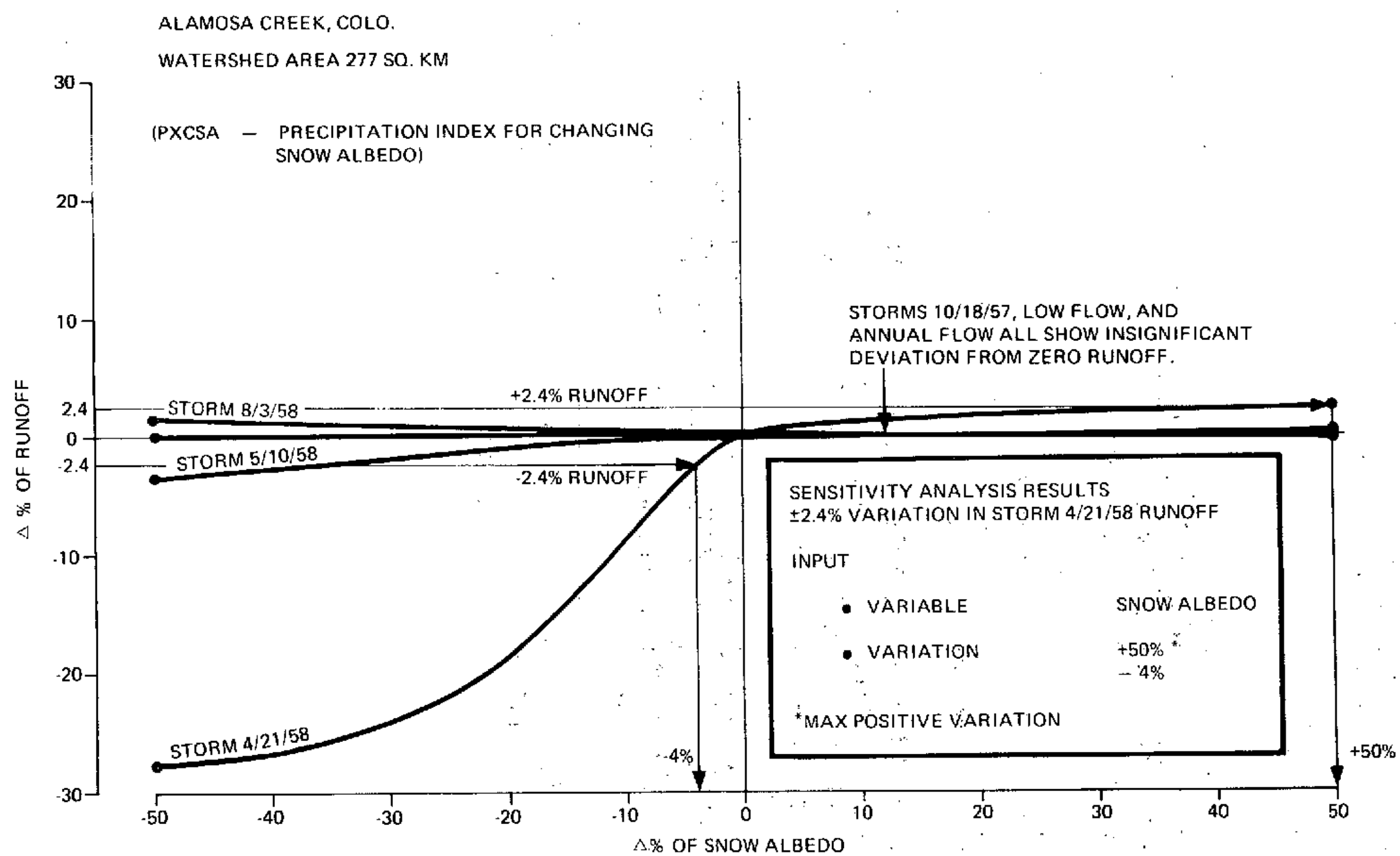


Figure 6-40. Snow Albedo Index Study

6.4 REFERENCES, SECTION 6

1. Anderson, Eric A. and Norman H. Crawford, 1964: "The synthesis of continuous snowmelt runoff hydrographs on a digital computer." Technical Report No. 36, I.D. 71-72-11, Department of Civil Engineering, Stanford University, Stanford, California, 103 p.

2. Chow, V. T., 1964: "Handbook of applied hydrology." New York: McGraw-Hill.

3. Liou, E. Y., OPSET: Program for Computerized Selection of Watershed Parameter Values for the Stanford Watershed Model, Lexington: University of Kentucky, Water Resources Institute, Research Report No. 34, 1970.

4. Ricca, Vincent T., 1972: "The Ohio State University version of the Stanford streamflow simulation model: Part I - Technical Aspects, May 1972." Office of Water Resources Research, U. S. Department of the Interior, 144 p.

5. Ricca, Vincent T., 1972: "The Ohio State University version of the Stanford streamflow simulation model: Part III - User's Manual, August 1972." Office of Water Resources Research, U. S. Department of the Interior, 68 p.

6. Ross, G. A., The Stanford Watershed Model: The Correlation of Parameter Values Selected by a Computerized Procedure with Measurable Physical Characteristics of the Watershed, Lexington: University of Kentucky Water Resources Institute, Research Report No. 35, 1970.

7. Striffler, W. D., "Users Manual for the Colorado State University Version of the Kentucky Watershed Model," Colorado State University, published under NASA Contract NAS9-13142, September 1973.

SECTION 7

RELATED TECHNICAL ARTICLES AND ABSTRACTS

In previous studies, the study team has collected a small library of books and technical articles dealing with environmental applications of remote sensing and the multitude of disciplines involved in all its aspects. Appendix D of this volume contains a nearly complete listing ("nearly complete," because additions have been made since the index was updated) of literature items and abstracts. Listings by keyword are also available.

APPENDIX A

SAMPLE SIMULATION RUN OUTPUT, SMALL WATERSHED MODEL

The watershed designated "Town Creek near Geraldine, Alabama," was one of a number studied by IBM under a previous NASA contract. Six years of usable historical data had previously been collected, using two hourly and five daily precipitation stations, and model calibration had been completed. The basin is representative of temperate-climate rural areas of moderate topography.

The basin is located in northeast Alabama, at the edge of the Tennessee River Valley, in the Cumberland Plateau physiographic region. Its area (see Figure A-1) is 365 square kilometers (141 square miles), approximately 65% moderately forested and 35% cultivated. Impervious surfaces and water surfaces represent approximately 0.2% and 0.1%, respectively, of the entire watershed area. Surface soil is predominately sandy loam; the watershed is, in fact, located on top of what is known as "Sand Mountain." The stream channels are generally deep and steep-sided, without well-defined flood plains; overflows have not occurred, even after the heaviest of recent precipitation events (e.g., March 1973).

Most accurate simulation was achieved using climatological data for water year 1964 (October 1963 through September 1964). A comparison of some single-year and long-term statistics is included in Figure A-1. Although October was one of the dries t months ever recorded, total precipitation was approximately 8% over the long-term average. Some heavy rains occurred in March 1964 (approximately 10 inches on March 25) but did not cause damage.

The observed daily discharge used in original model calibration is that recorded by USGS Gage 3-5729. The data was tabulated in Table A-1. Mean basin hourly precipitation was synthesized from two hourly and five daily precipitation stations.

Page A-4 and subsequent pages of this appendix contain a reproduction of the printout from one simulation run in which the parameter BMIR was perturbed by -50%, from a reference value of 7.0.

Print plots have been omitted from the report, in favor of SC4020 plots. In the plots, "P," "R," and "S" indicate precipitation (unscaled), reference and simulated.

STATISTICAL DATA		
STATISTIC	LONG TERM	1964*
Average Discharge, m^3/s	8.04	9.20
Peak Discharge, m^3/s	500.9	243.2
Least Discharge,	0	0
Annual Precipitation, cm	137	148

*Reference values used in sensitivity analysis

Area	335 km^2
Minimum Elevation	305 m
Maximum Elevation	594 m
Mean Surface Slope	0.062 m/m

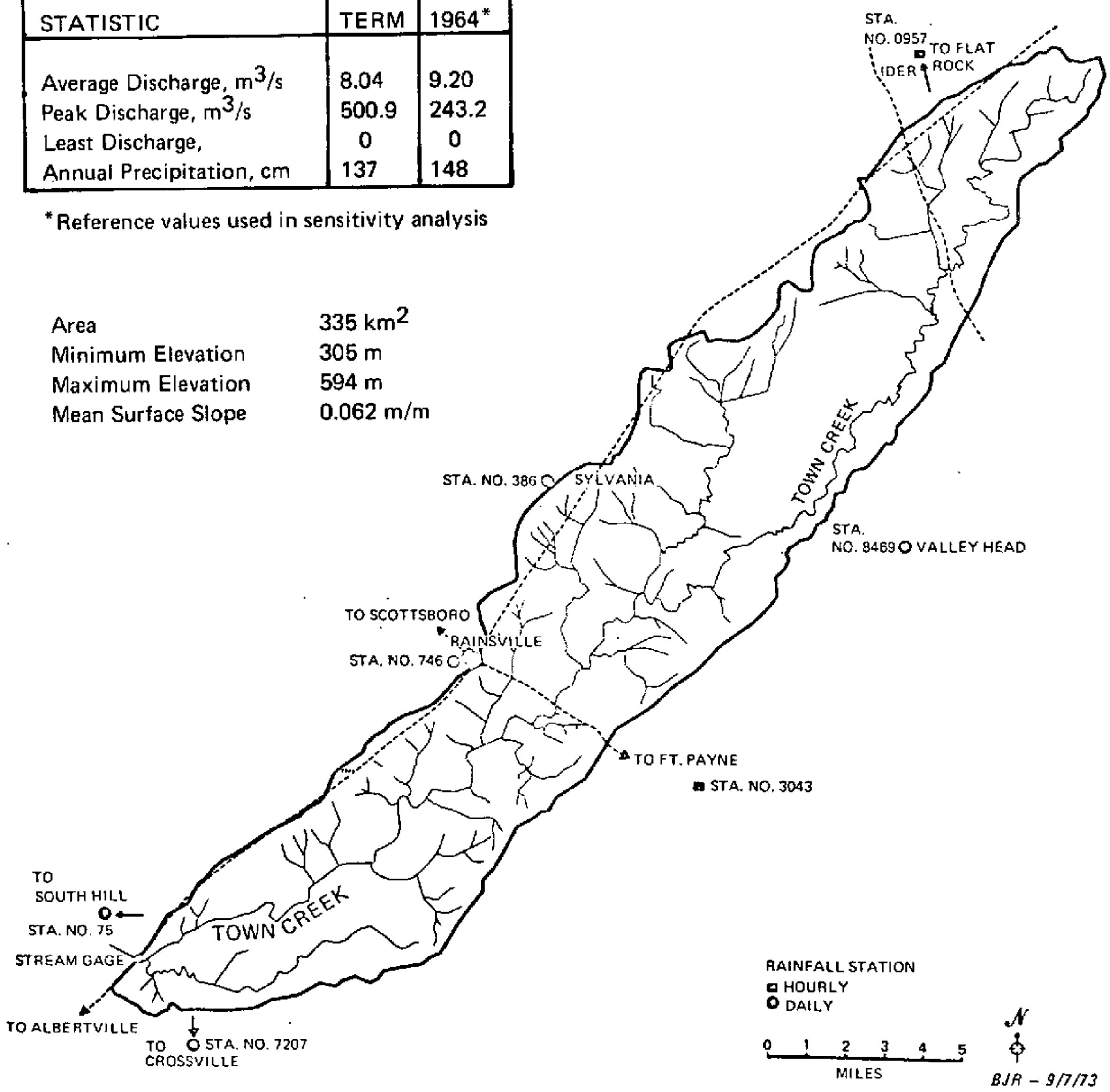


Figure A-1. Town Creek Watershed

Table A-1. Town Creek Observed Discharge Data, WY 1964

TENNESSEE RIVER BASIN

3-5729. Town Creek near Geraldine, Ala.

Location.--Lat 34°22'42", long 85°59'25", in SE¼ sec. 34, T. 7 S., R. 6 E., on downstream side of bridge on State Highway 75, 1,600 ft downstream from Reedy Creek, 4,500 ft upstream from Traylor Branch, 2 miles north northeast of Geraldine, and 15 miles northeast of Albertville.

Drainage area.--141 sq mi.

Records available.--July 1957 to September 1964.

Gage.--Water-stage recorder. Altitude of gage is 1,000 ft (from topographic map).

Average discharge.--7 years, 284 cfs.

Extremes.--Maximum discharge during year, 10,700 cfs Mar. 25 (gage height, 15.72 ft); no flow Oct. 5 to Nov. 23.
1957-64: Maximum discharge, 17,700 cfs Apr. 29, 1963 (gage height, 21.70 ft); no flow Sept. 6-13, 1957, July 17, 19-21, 24-29, 1960, Sept. 23, 24-27, 28, Oct. 5 to Nov. 23, 1963.

Remarks.--Records good.

Discharge, in cubic feet per second, water year October 1963 to September 1964

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	0.1	0	42	129	424	307	430	*490	28	6.1	304	13
2	.1	0	*26	124	358	965	*379	1,400	31	3.6	131	11
3	.1	0	19	149	316	1,450	340	3,040	31	2.2	75	8.8
4	.1	0	16	272	288	1,160	550	1,160	25	1.9	48	7.3
5	0	0	12	346	295	2,340	556	759	19	2.2	75	6.4
6	0	0	11	415	424	984	1,970	574	32	*4.2	46	5.5
7	0	0	9.2	774	379	742	2,230	469	60	3.4	36	4.7
8	0	0	10	*586	322	662	1,730	391	54	2.6	28	3.9
9	0	0	11	1,770	293	602	984	337	32	2.4	22	3.2
10	*0	0	11	1,070	271	686	726	310	22	25	18	2.5
11	0	0	206	694	258	528	581	266	18	124	15	2.2
12	0	0	862	558	233	457	607	223	14	326	*37	1.8
13	0	0	436	467	321	406	3,070	190	10	429	27	1.4
14	0	0	372	366	478	2,280	2,280	160	9.0	169	19	1.3
15	0	0	287	320	517	7,980	1,020	140	15	107	15	1.1
16	0	0	217	290	764	2,220	746	118	14	68	35	*1.0
17	0	0	176	271	556	1,060	598	101	9.0	50	451	.8
18	0	0	154	246	*782	786	497	86	7.2	36	166	.8
19	0	0	126	222	718	638	427	72	5.5	28	94	.8
20	0	0	108	290	567	620	367	62	4.0	320	61	.8
21	0	0	97	292	472	630	313	54	3.0	390	42	.7
22	0	0	88	244	421	542	274	46	2.4	164	33	.6
23	0	0	110	225	367	466	271	42	5.2	132	29	.5
24	0	.1	116	1,700	331	412	595	50	56	299	30	.4
25	0	.3	106	5,380	367	4,710	881	*41	34	155	27	.4
26	0	.3	118	1,470	394	6,120	795	33	15	178	22	.4
27	0	.4	131	872	334	1,470	1,560	28	9.0	116	18	.4
28	0	.8	129	658	349	939	1,080	25	5.5	70	89	.3
29	*0	78	116	528	343	710	813	25	3.6	48	31	.9
30	0	90	104	457	------	567	602	28	2.6	40	20	2.0
31	0	------	106	430	------	525	------	26	------	214	15	------
Total	0.4	169.9	4,332.2	21,615	11,942	43,964	27,272	10,746	576.0	3,516.6	2,059	84.9
Mean	0.01	5.66	140	697	412	1,418	909	347	19.2	113	66.4	2.83
Cfsm	0.000071	0.040	0.993	4.94	2.92	10.1	6.45	2.46	0.136	0.801	0.471	0.020
In.	0.0001	0.04	1.14	5.70	3.15	11.60	7.19	2.83	0.15	0.93	0.54	0.02

Calendar year 1963: Max 9,620 Min 0 Mean 244 Cfsm 1.73 In. 23.48
Water year 1963-64: Max 7,980 Min 0 Mean 345 Cfsm 2.45 In. 33.29

Peak discharge (base, 4,800 cfs)

Date	Time	Gage height	Discharge	Date	Time	Gage height	Discharge
1-25	0400	13.00	8,000	3-25	2400	15.72	10,700
3-15	0730	14.85	9,850	4-13	0600	9.70	4,860

* Discharge measurement made on this day.

```
S059   *TOWN CREEK NR, GERALDINE ALA.    (141.0 SQ. MI.)   WY64 STUDY
         *CONTROL OPTIONS (BALANCE OF DATA VARIES WITH SPECIFIED OPTIONS
*(1)  (2)  (3)  (4)  (5)  (6)  (7)  (8) (9)(10)(11)(12) (13)(14)(15)(16)
  0    1    0    1    1    1    0    2   1  0    0   1   0    1   0  1
* TIME - AREA HISTOGRAM DEFINITION
* NBTRI-BTRI(1)      (2)      (3)      (4)      (5)      (6)      (7)      (8)
   16      0.043    0.061  0.071  0.086  0.054  0.079  0.071  0.085
* BTRI- (9)    (10)     (11)     (12)     (13)     (14)     (15)     (16)
        0.085 0.083   0.069  0.026  0.023  0.070  0.049  0.045
 0.0      * OUTPUT PARAMETER -  RMPF, IF ANY DAILY FLOW EXCEEDS RMPF
* WATERSHED PARAMETERS - RGPMB - AREA   -   FIMP   -   FWTP
                                 1.0   141.0     .002       .001
* SOIL MOISTURE PARAMETERS
* VINTMR-BUZC- SUZC - LZC - ETLF - SUBWF - GWETF- STAC - BMIR - BIVF
  0.15    0.20  0.20    4.0     .20     0.0      0.0     .25     3.5    0.50
* OVERLAND FLOW PARAMETERS - OFSS - OFSL - OFMN - OFMNIS - IFRC
                                0.062 1550.0  0.05    0.014     0.184
*CHANNEL ROUTING AND GROUND WATER PARAMETERS
*    CSRX - FSRX - CHCAP - EXOPV - BFNLR - BFRC
     0.94    0.94    4800.0  0.25     0.85    0.93
*MOISTURE STORAGE VALUES - GWS   -   UZS - LZS    -    BFNX   -    IFS
                                 0.0      0.0   0.40        0.04       0.0
6        *(JULDI) NUMBER OF JULIAN DATES REQUESTED FOR RUNOFF PLOTS
308 121 23 121 46 121 73 121 122 121 227 121
         * LAST TWO DIGITS IN CALENDER YEAR OF THE WATER YEAR TO BE RUN
63 64    * YEAR1 - YEAR2
         * EVAPORATION DATA
         * IF CONOPT(3)=0  DAILY EVAPORATION DATA ARE READ                        50
0.18 0.13 0.07 0.07 0.10 0.12 0.09 0.12 0.15 0.13                          *1 OCT'63
0.12 0.10 0.15 0.13 0.17 0.13 0.11 0.11 0.11 0.10                          *2 OCT'63
0.03 0.04 0.09 0.08 0.09 0.12 0.11 0.09 0.09 0.08 0.07                     *3 OCT'63
0.13 0.15 0.13 0.07 0.03 0.03 0.07 0.09 0.03 0.11                          *1 NOV'63
0.06 0.04 0.03 0.01 0.01 0.06 0.10 0.05 0.03 0.02                          *2 NOV'63
0.05 0.01 0.01 0.04 0.11 0.02 0.04 0.03 0.05 0.04                          *3 NOV'63
0.03 0.02 0.00 0.04 0.01 0.13 0.09 0.02 0.06 0.02                          *1 DEC'63
0.00 0.00 0.01 0.08 0.03 0.01 0.00 0.04 0.09 0.06                          *2 DEC'63
0.03 0.02 0.04 0.07 0.01 0.02 0.00 0.03 0.03 0.02 0.02                     *3 DEC'63
0.01 0.01 0.02 0.02 0.02 0.00 0.09 0.00 0.01 0.01                          *1 JAN'64
0.01 0.02 0.02 0.02 0.02 0.02 0.08 0.04 0.02 0.02                          *2 JAN'64
0.02 0.00 0.04 0.04 0.03 0.03 0.06 0.02 0.02 0.12 0.10                     *3 JAN'64
0.04 0.03 0.10 0.07 0.07 0.04 0.06 0.03 0.11 0.15                          *1 FEB'64
0.05 0.06 0.07 0.13 0.10 0.03 0.08 0.06 0.12 0.13                          *2 FEB'64
0.03 0.04 0.11 0.11 0.07 0.03 0.06 0.08 0.05                               *3 FEB'64
0.05 0.06 0.09 0.04 0.05 0.00 0.01 0.03 0.03 0.04                          *1 MAR'64
0.05 0.11 0.28 0.06 0.15 0.11 0.10 0.11 0.08 0.04                          *2 MAR'64
0.14 0.10 0.05 0.12 0.11 0.06 0.09 0.14 0.12 0.17 0.05                     *3 MAR'64
0.06 0.13 0.07 0.12 0.13 0.05 0.01 0.03 0.16 0.22                          *1 APR'64
0.08 0.08 0.07 0.10 0.15 0.15 0.16 0.09 0.18 0.29                          *2 APR'64
0.03 0.24 0.25 0.11 0.16 0.18 0.18 0.21 0.07 0.20                          *3 APR'64
0.15 0.25 0.20 0.21 0.13 0.23 0.24 0.22 0.23 0.17                          *1 MAY'64
0.21 0.08 0.21 0.24 0.26 0.27 0.26 0.22 0.24 0.24                          *2 MAY'64
0.23 0.27 0.24 0.27 0.19 0.20 0.23 0.24 0.31 0.22 0.13                     *3 MAY'64
0.16 0.18 0.16 0.17 0.21 0.12 0.20 0.23 0.22 0.18                          *1 JUN'64
0.17 0.12 0.02 0.27 0.20 0.26 0.23 0.26 0.24 0.24                          *2 JUN'64
0.16 0.24 0.22 0.23 0.16 0.19 0.12 0.04 0.14 0.14                          *3 JUN'64
0.23 0.15 0.30 0.15 0.20 0.18 0.06 0.09 0.22 0.17                          *1 JUL'64
0.25 0.21 0.24 0.27 0.26 0.22 0.24 0.19 0.29 0.24                          *2 JUL'64
0.26 0.21 0.27 0.25 0.23 0.04 0.26 0.24 0.16 0.07 0.21                     *3 JUL'64
0.24 0.19 0.15 0.13 0.15 0.21 0.22 0.15 0.18 0.27                          *1 AUG'64
0.21 0.19 0.17 0.14 0.22 0.20 0.22 0.12 0.19 0.19                          *2 AUG'64
0.11 0.18 0.16 0.22 0.20 0.21 0.20 0.24 0.25 0.25 0.22                     *3 AUG'64
0.19 0.17 0.11 0.19 0.12 0.15 0.14 0.13 0.14 0.13                          *1 SEP'64
0.11 0.23 0.20 0.19 0.16 0.14 0.02 0.14 0.20 0.13                          *2 SEP'64
0.22 0.08 0.11 0.17 0.13 0.03 0.02 0.17 0.10 0.11                          *3 SEP'64
         * IF CONOPT(3)=0  MONTHLY PAN COEFFICIENTS ARE READ                      51
 0.70 0.70 0.40 0.48 0.49 0.60 0.70 0.70 0.70 0.79 0.76 0.70
```

* STREAMFLOW DATA - TOWN CREEK, ALA. (141 SQ. MILES) WY 64

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*OCT
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*OCT
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*OCT
0.0										*OCT
8.9	5.0	1.3	17.7	427.9	82.6	71.9	67.1	62.5	57.9	*NOV
54.0	50.2	46.7	43.5	40.4	37.4	34.7	32.4	30.1	28.0	*NOV
26.0	24.3	22.6	20.9	19.2	18.1	16.8	15.6	20.6	17.3	*NOV
16.0	19.0	19.5	17.7	16.7	15.5	14.4	29.3	24.6	24.2	*DEC
76.8	166.4	138.5	173.4	159.7	149.3	139.3	129.9	120.9	112.5	*DEC
104.6	107.7	190.2	160.4	145.4	134.8	125.4	116.7	108.5	100.9	*DEC
142.8										*DEC
512.6	254.0	204.8	185.5	171.8	295.2	440.9	268.6	2523.1	480.3	*JAN
305.8	276.5	267.5	248.1	231.1	215.3	200.3	186.2	179.0	321.0	*JAN
240.6	197.3	178.4	2377.4	5271.7	582.2	379.6	328.9	301.1	278.7	*JAN
286.4										*JAN
289.9	253.9	232.2	215.2	233.4	371.3	280.4	237.4	215.9	200.3	*FEB
187.3	173.9	162.8	152.8	943.0	1268.7	303.4	680.9	438.4	290.3	*FEB
248.9	227.1	210.1	195.1	249.8	262.1	216.0	248.9	239.4		*FEB
209.0	1585.9	2093.4	506.7	1563.6	451.0	338.9	339.3	373.9	1077.2	*MAR
358.1	283.2	254.6	3832.7	3175.9	847.6	512.8	427.1	407.4	446.9	*MAR
536.8	411.1	350.4	319.3	3855.7	5430.9	928.5	556.3	467.0	424.2	*MAR
392.0										*MAR
363.6	337.2	313.2	555.8	517.5	1834.9	3055.8	1928.4	661.6	499.9	*APR
443.7	567.6	2702.8	1845.3	708.1	540.5	480.4	441.8	408.9	379.0	*APR
352.3	326.3	331.8	573.0	1114.5	1020.6	1408.4	721.4	498.8	403.5	*APR
363.1	2015.6	3765.1	733.0	490.4	421.9	385.3	356.2	330.6	307.1	*MAY
284.8	264.6	245.2	227.5	211.0	195.8	181.7	168.8	156.6	145.3	*MAY
134.9	125.1	116.2	107.8	100.2	93.0	86.3	81.3	79.7	72.1	*MAY
68.5										*MAY
73.4	66.6	61.8	57.3	53.1	510.7	272.0	159.7	144.4	133.1	*JUN
123.6	114.9	560.7	151.9	122.6	112.7	104.7	97.2	90.3	83.8	*JUN
78.0	72.3	89.2	204.8	124.5	114.8	108.9	101.6	94.2	87.4	*JUN
94.5	94.6	95.6	90.9	82.7	76.9	73.8	94.2	86.9	332.4	*JUL
186.6	880.9	770.6	368.6	309.8	284.3	261.3	242.7	225.1	1203.4	*JUL
686.6	295.9	261.3	240.2	222.8	207.5	192.2	178.5	166.0	154.5	*JUL
143.0										*JUL
132.8	123.4	114.8	106.7	99.0	91.8	85.2	79.3	73.6	68.1	*AUG
63.4	59.0	54.8	51.0	298.0	337.9	153.5	141.2	131.0	121.7	*AUG
113.3	105.1	98.0	91.0	84.7	78.8	73.2	67.9	63.0	58.5	*AUG
54.4										*AUG
50.6	47.1	43.9	40.5	37.8	35.1	32.6	30.3	28.1	26.1	*SEP
24.3	22.3	20.7	19.2	17.9	16.7	15.8	16.3	14.4	13.0	*SEP
11.8	11.3	10.4	9.5	8.9	8.5	7.9	7.0	30.3	53.3	*SEP

* RAINFALL DATA - TOWN CREEK, ALA. (141 SQ. MILES) WY 64

0 * NSGRD.

0957	63	10	12	2	0.04	0.02	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0957	63	10	13	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	10	31	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	10	31	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.21	0.35	0.22	0.11
0957	63	11	1	2	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	4	2	0.00	0.04	0.12	0.16	0.11	0.19	0.21	0.14	0.41	0.71	0.37	0.21
0957	63	11	5	1	0.16	0.14	0.06	0.05	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0957	63	11	5	2	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	20	2	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
0957	63	11	22	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
0957	63	11	25	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	25	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	26	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	26	2	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	27	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	27	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0957	63	11	29	1	0.06	0.04	0.06	0.09	0.06	0.01	0.01	0.00	0.00	0.00	0.00	0.00

```
0957 63 11 29 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 11 30 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12  2 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.00 0.01 0.04
0957 63 12  2 2 0.07 0.02 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12  8 1 0.00 0.00 0.04 0.23 0.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12 10 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.06 0.13 0.12
0957 63 12 11 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.05 0.06 0.00
0957 63 12 11 2 0.03 0.05 0.15 0.06 0.02 0.00 0.00 0.08 0.19 0.02 0.05 0.02
0957 63 12 12 1 0.00 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.08 0.02
0957 63 12 12 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 63 12 13  3PM-MIDNITE  0.36 PRECIP DIST ESTIMATED          WF .045
0957 63 12 13 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.01 0.00 0.02
0957 63 12 13 2 0.04 0.04 0.03 0.03 0.03 0.00 0.00 0.00 0.05 0.05 0.03 0.03
*NWS 3043 63 12 14  1AM-4AM      0.11 PRECIP DIST ESTIMATED          WF .045
0957 63 12 14 1 0.02 0.02 0.02 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 63 12 22  5PM-MIDNITE  0.51 PRECIP DIST ESTIMATED          WF .136
0957 63 12 22 2 0.00 0.00 0.00 0.00 0.01 0.04 0.13 0.14 0.04 0.03 0.03 0.02
*NWS 0957 63 12 23  1AM-7AM      0.27 PRECIP DIST ESTIMATED          WF .136
0957 63 12 23 1 0.02 0.03 0.04 0.04 0.06 0.03 0.02 0.00 0.00 0.00 0.00 0.00
0957 63 12 23 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12 24 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12 26 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12 27 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 63 12 27 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 63 12 31  2PM-11PM     1.00 PRECIP DIST ESTIMATED          WF .045
0957 63 12 31 2 0.00 0.13 0.02 0.03 0.01 0.17 0.18 0.01 0.02 0.13 0.17 0.00
*NWS 3043 64 01 01  1AM-7AM      0.23 PRECIP DIST ESTIMATED          WF .045
0957 64  1  1 1 0.03 0.04 0.03 0.03 0.03 0.02 0.03 0.00 0.00 0.00 0.00 0.00
0957 64  1  3 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  4 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  4 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 64 01 06  10AM-10PM    0.52 PRECIP DIST ESTIMATED          WF .045
0957 64  1  6 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.03 0.06 0.11
0957 64  1  6 2 0.15 0.16 0.07 0.01 0.00 0.01 0.01 0.03 0.03 0.04 0.01 0.00
0957 64  1  7 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  7 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  8 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  8 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.24 0.09 0.47
0957 64  1  9 1 0.31 0.09 0.04 0.04 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1  9 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 10 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 11 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 11 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 12 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.03 0.02 0.00
0957 64  1 12 2 0.01 0.01 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 13 1 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 13 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 14 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 64 01 19  11PM-MIDNITE 0.23 PRECIP DIST ESTIMATED          WF .045
0957 64  1 19 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.15 0.03 0.08 0.05
*NWS 3043 64 01 20  1AM-3AM      0.07 PRECIP DIST ESTIMATED          WF .045
0957 64  1 20 1 0.10 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 24 1 0.00 0.01 0.00 0.00 0.01 0.14 0.18 0.33 0.19 0.09 0.07 0.07
0957 64  1 24 2 0.01 0.07 0.29 0.06 0.08 0.86 0.60 0.05 0.15 0.03 0.00 0.00
0957 64  1 25 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  1 31 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.06 0.06 0.06 0.02
0957 64  1 31 2 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2  5 2 0.08 0.10 0.06 0.03 0.00 0.08 0.03 0.11 0.05 0.00 0.00 0.05
0957 64  2  6 1 0.03 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2  6 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2  7 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2  7 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2 10 2 0.00 0.00 0.00 0.00 0.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  2 13 1 0.00 0.00 0.00 0.00 0.00 0.03 0.01 0.00 0.00 0.00 0.00 0.00
```

```
0957 64   2 13 2 0.00 0.01 0.04 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 15 1 0.00 0.00 0.00 0.01 0.07 0.02 0.03 0.01 0.01 0.02 0.15 0.18
0957 64   2 15 2 0.37 0.25 0.11 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 16 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 64 02 17  10PM-MIDNITE 0.30 PRECIP DIST ESTIMATED          WF .045
0957 64   2 17 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.04 0.09
*NWS 3043 64 02 18  1AM-7AM       0.45 PRECIP DIST ESTIMATED          WF .045
0957 64   2 18 1 0.15 0.15 0.09 0.00 0.00 0.01 0.08 0.07 0.01 0.00 0.00 0.00
0957 64   2 18 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01
0957 64   2 19 1 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.03 0.00 0.00 0.00 0.00
0957 64   2 21 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 21 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 22 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 25 1 0.00 0.00 0.01 0.09 0.08 0.04 0.01 0.03 0.06 0.08 0.02 0.03
0957 64   2 25 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 26 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 27 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 27 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 28 1 0.00 0.04 0.04 0.03 0.07 0.06 0.01 0.01 0.02 0.02 0.00 0.00
0957 64   2 29 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   2 29 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3  1 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.03
0957 64   3  1 2 0.00 0.00 0.01 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3  2 1 0.00 0.01 0.01 0.00 0.00 0.00 0.00 0.04 0.07 0.10 0.13 0.27
0957 64   3  2 2 0.36 0.33 0.24 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3  4 1 0.00 0.00 0.00 0.04 0.02 0.00 0.01 0.02 0.02 0.01 0.00 0.00
0957 64   3  4 2 0.00 0.00 0.00 0.00 0.00 0.04 0.14 0.23 0.31 0.00 0.00 0.00
0957 64   3  6 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3  6 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3  7 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.04 0.02 0.04
0957 64   3  7 2 0.02 0.01 0.00 0.00 0.00 0.03 0.00 0.05 0.00 0.00 0.00 0.00
0957 64   3  9 2 0.00 0.00 0.00 0.02 0.00 0.00 0.03 0.36 0.03 0.05 0.00 0.00
0957 64   3 10 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 14 1 0.00 0.00 0.00 0.00 0.00 0.05 0.08 0.31 0.90 0.36 0.29 0.03
0957 64   3 14 2 0.02 0.04 0.09 0.21 0.15 0.10 0.06 0.04 0.04 0.09 0.05 0.06
0957 64   3 15 1 0.16 0.11 0.11 0.04 0.04 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 18 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 18 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 19 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 19 2 0.02 0.05 0.06 0.08 0.09 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 20 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.17 0.01 0.02
0957 64   3 21 1 0.04 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 21 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 22 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   3 25 1 0.01 0.01 0.32 0.21 0.16 0.39 0.44 0.22 0.15 0.03 0.00 0.03
0957 64   3 25 2 0.08 0.09 0.10 0.33 0.32 0.08 0.00 0.00 0.65 0.27 0.06 0.04
0957 64   3 26 1 0.03 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  1 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  1 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  2 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  2 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  3 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  3 2 0.00 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.06 0.00 0.04
0957 64   4  4 1 0.05 0.07 0.13 0.01 0.09 0.21 0.06 0.07 0.01 0.00 0.00 0.00
0957 64   4  5 2 0.00 0.00 0.00 0.00 0.00 0.03 0.06 0.18 0.19 0.18 0.12 0.11
*NWS 0957 64 04 06  3AM-5AM       0.33 PRECIP DIST ESTIMATED          WF .136
0957 64   4  6 1 0.24 0.09 0.11 0.08 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4  6 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 04 07  2PM-9PM       0.60 PRECIP DIST ESTIMATED          WF .136
0957 64   4  7 1 0.00 0.00 0.00 0.00 0.00 0.04 0.39 0.03 0.01 0.53 0.28 0.01
0957 64   4  7 2 0.00 0.03 0.00 0.00 0.02 0.11 0.00 0.11 0.02 0.00 0.00 0.00
0957 64   4  8 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   4 12 1 0.00 0.00 0.00 0.01 0.00 0.02 0.04 0.06 0.09 0.10 0.17 0.06
0957 64   4 12 2 0.06 0.08 0.03 0.02 0.02 0.04 0.03 0.01 0.01 0.00 0.00 0.00
```

```
0957 64  4 13 1 0.00 0.00 0.03 0.14 0.29 0.11 0.03 0.00 0.28 0.28 0.22 0.05
0957 64  4 13 2 0.16 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 22 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 22 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 23 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 23 2 0.00 0.00 0.00 0.00 0.13 0.23 0.23 0.03 0.00 0.00 0.00 0.00
0957 64  4 24 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.08 0.05
0957 64  4 24 2 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.27 0.20 0.03
0957 64  4 25 1 0.02 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 04 26  11PM-MIDNITE 0.05 PRECIP DIST ESTIMATED          WF .136
0957 64  4 26 1 0.00 0.16 0.25 0.10 0.04 0.02 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 26 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.08 0.12
*NWS 0957 64 04 27  1AM-3AM      0.12 PRECIP DIST ESTIMATED          WF .136
0957 64  4 27 1 0.23 0.23 0.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 04 28  4AM-5AM      0.11 PRECIP DIST ESTIMATED          WF .136
0957 64  4 28 1 0.00 0.00 0.00 0.06 0.12 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 28 2 0.00 0.00 0.00 0.00 0.00 0.08 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 29 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  4 29 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5  1 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5  1 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 05 02  8AM-MIDNITE  1.74 PRECIP DIST ESTIMATED          WF .136
0957 64  5  2 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.15 0.16 0.01 0.05 0.12
0957 64  5  2 2 0.23 0.55 0.60 0.34 0.20 0.13 0.03 0.02 0.11 0.08 0.06 0.04
0957 64  5  3 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5  9 2 0.00 0.02 0.06 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 10 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 10 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 11 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 20 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 20 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 21 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 22 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02
0957 64  5 23 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 23 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 24 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  5 27 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.03 0.00 0.00 0.00 0.00
0957 64  5 28 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01
0957 64  5 28 2 0.00 0.00 0.00 0.00 0.00 0.00 0.27 0.02 0.00 0.00 0.00 0.00
0957 64  5 31 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.02 0.02 0.02 0.02
0957 64  5 31 2 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02
0957 64  6  1 1 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.00 0.00 0.00 0.00 0.00
0957 64  6  1 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6  2 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 3043 64 06 06  2AM-7AM     -0.99 PRECIP DIST ESTIMATED          WF .045
0957 64  6  6 1 0.00 0.01 0.01 0.14 0.20 0.19 0.34 0.27 0.20 0.05 0.03 0.00
0957 64  6  8 2 0.07 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 11 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 12 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.10 0.00 0.00
0957 64  6 13 1 0.63 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 15 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 15 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 16 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 23 2 0.00 0.00 0.00 0.00 0.00 0.05 0.57 0.21 0.16 0.11 0.03 0.00
0957 64  6 24 1 0.00 0.01 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  6 24 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.03 0.00 0.00 0.00 0.00
0957 64  6 26 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01
0957 64  6 26 2 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
0957 64  6 27 1 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  6 30 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01
0957 64  7  1 1 0.00 0.00 0.00 0.00 0.00 0.00 0.11 0.08 0.11 0.12 0.01 0.01
0957 64  7  1 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7  2 2 0.00 0.00 0.00 0.00 0.00 0.33 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  7  3 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.22 0.00 0.00 0.00 0.00
0957 64  7  7 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.02 0.02 0.02 0.02
```

```
0957 64  7  7 2 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02
0957 64  7  8 1 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.11 0.00 0.00 0.00 0.00
0957 64  7 10 1 0.00 0.00 0.00 0.00 0.00 0.00 0.50 0.23 0.00 0.00 0.00 0.00
0957 64  7 10 2 0.00 0.00 0.07 0.06 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 11 2 0.00 0.02 0.01 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 07 12  9AM-6PM       0.42 PRECIP DIST ESTIMATED          WF .136
0957 64  7 12 1 0.00 0.00 0.00 0.00 0.35 0.24 0.11 0.28 0.23 0.24 0.21 0.30
0957 64  7 12 2 0.04 0.00 0.00 0.00 0.00 0.15 0.00 0.00 0.02 0.00 0.00 0.00
0957 64  7 15 2 0.00 0.02 0.00 0.03 0.14 0.07 0.01 0.00 0.00 0.00 0.01 0.00
0957 64  7 16 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 16 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 17 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 17 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 18 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 18 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 19 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 19 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 20 1 0.00 0.00 0.00 0.00 0.20 0.01 0.22 0.16 0.68 0.10 0.01 0.00
0957 64  7 20 2 0.00 0.00 0.19 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 21 2 0.00 0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 22 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01
0957 64  7 22 2 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
0957 64  7 23 1 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  7 23 2 0.04 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 24 2 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  7 25 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 25 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 26 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 26 2 0.00 0.00 0.00 0.00 0.00 0.00 0.08 0.00 0.00 0.00 0.00 0.00
0957 64  7 30 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  7 30 2 0.02 0.01 0.01 0.00 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  8  4 1 0.00 0.00 0.02 0.01 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8  4 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8  5 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8  5 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8  6 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 10 2 0.00 0.00 0.00 0.00 0.00 0.07 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 11 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.01
0957 64  8 11 2 0.03 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 14 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00
0957 64  8 15 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.20 0.10 0.30
0957 64  8 15 2 0.53 0.20 0.15 0.13 0.10 0.05 0.00 0.00 0.00 0.00 0.00 0.00
*NWS 0957 64 08 16  4AM-9PM       1.22 PRECIP DIST ESTIMATED          WF .136
0957 64  8 16 1 0.00 0.00 0.00 0.00 0.00 0.00 0.08 0.05 0.05 0.00 0.00 0.00
0957 64  8 16 2 0.00 0.00 0.00 0.00 0.08 0.04 0.02 0.00 0.05 0.00 0.00 0.00
0957 64  8 17 1 0.00 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 21 2 0.00 0.00 0.00 0.00 0.08 0.00 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  8 22 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.00
0957 64  8 22 2 0.00 0.00 0.00 0.00 0.03 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 23 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.05 0.05
0957 64  8 23 2 0.00 0.00 0.00 0.00 0.00 0.00 0.02 0.00 0.00 0.00 0.00 0.00
0957 64  8 25 2 0.00 0.00 0.10 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 26 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 27 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01
0957 64  8 27 2 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.01
0957 64  8 28 1 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00
0957 64  8 28 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 29 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.01 0.01 0.01
0957 64  8 29 2 0.01 0.01 0.01 0.01 0.01 0.01 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 30 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  8 31 2 0.00 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  9 11 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01 0.00 0.00
0957 64  9 12 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64  9 17 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
```

```
0957 64   9 17 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 18 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.18 0.03 0.02 0.00
0957 64   9 18 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.05 0.00 0.00 0.00
0957 64   9 19 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 19 2 0.00 0.00 0.00 0.00 0.04 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 23 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 23 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 24 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 28 1 0.00 0.00 0.02 0.05 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 64   9 29 1 0.00 0.01 0.04 0.21 0.05 0.02 0.00 0.00 0.00 0.00 0.00 0.02
0957 64   9 29 2 0.24 0.14 0.29 0.14 0.17 0.04 0.00 0.00 0.01 0.02 0.01 0.02
0957 64   9 30 1 0.03 0.00 0.00 0.01 0.00 0.01 0.01 0.00 0.00 0.00 0.00 0.00
0957 64   9 30 2 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0957 98   9 30 1
```

```
*STORM  14 64
* TOWN CREEK, ALA. (141 SQ. MI)          11/05/63  STORM  STUDY
1.0 141.0 121 -1 1
1.0
     1.6      1.5      1.5      1.5      1.5      1.5      1.5      1.5      1.1
     1.1      1.1      1.1      1.1      1.1      1.2      1.6      2.6      4.6
     7.7     11.2     19.0     41.5    110.1    206.0    308.5    410.4    466.9
   521.7    566.7    614.2    657.3    687.5    689.7    638.3    576.3    567.3
   560.4    538.1    469.4    391.4    325.6    272.8    230.6    197.3    171.3
   150.9    134.8    122.3    112.4    104.7     98.6     93.9     90.1     87.2
    84.8     83.0     81.3     80.1     79.2     78.4     77.7     77.2     76.7
    76.4     76.0     75.7     75.4     75.2     75.1     74.8     74.6     74.4
    74.2     73.9     73.8     73.6     73.4     73.2     73.1     72.9     72.3
    72.2     72.0     71.8     71.6     71.4     71.3     71.1     70.9     70.7
    70.5     70.3     70.4     70.2     70.0     69.8     69.6     69.4     69.2
    69.0     68.8     68.6     68.4     68.2     67.5     67.3     67.1     66.9
    66.7     66.5     66.3     66.1     65.9     65.7     65.5     65.3     65.6
    65.4     65.2     65.0
```

```
* TOWN CREEK. ALA. (141 SQ. MI)          01/25/64  STORM  STUDY
1.0 141.0 121 -1 1
1.0
   186.0    185.3    184.6    183.9    183.2    182.6    181.9    181.3    180.5
   179.8    179.2    178.5    177.9    177.3    176.6    176.0    175.4    174.7
   174.1    173.6    173.1    172.5    172.0    171.4    170.8    170.2    169.7
   169.2    168.7    180.8    202.5    253.4    437.8    751.8   1111.1   1465.5
  1708.3   1919.2   2133.2   2419.6   2745.3   3082.3   3761.3   4721.6   5799.6
  7023.7   7927.6   8564.4   9026.5   9361.6   9639.1   9821.4   9839.7   9284.8
  8378.2   7904.2   7715.8   7376.4   6585.9   5507.8   4548.6   3771.4   3148.9
  2653.7   2259.1   1943.9   1691.1   1487.4   1322.5   1188.3   1078.3    987.6
   912.3    849.3    796.3    751.1    712.5    679.1    650.0    624.5    601.8
   581.7    563.7    547.5    532.7    519.3    507.1    495.8    485.3    475.6
   466.7    458.4    450.8    443.5    436.8    430.4    424.5    418.9    413.6
   408.7    404.0    399.6    395.4    391.5    387.5    383.9    380.6    377.4
   374.3    371.4    368.6    366.0    363.3    360.8    358.5    356.2    354.2
   352.1    350.1    348.2
```

* TOWN CREEK, ALA. (141 SQ. MI)   02/15/64   STORM   STUDY

1.0 141.0 121 -1 1

1.0

147.2	146.7	146.3	145.9	148.4	149.9	152.5	152.8	153.2
155.4	170.9	192.9	234.4	406.7	734.3	1115.9	1502.2	1786.9
2009.6	2219.8	2430.8	2638.7	2808.2	2883.9	2779.8	2570.2	2482.9
2482.0	2433.9	2237.5	1941.8	1661.9	1432.5	1247.5	1097.5	975.3
875.1	792.5	723.7	666.2	617.5	576.2	540.7	510.1	483.5
460.0	439.3	420.9	404.3	389.4	376.0	363.7	352.5	342.2
332.7	324.0	315.6	308.1	301.1	294.7	288.6	283.0	277.7
272.7	268.0	263.7	259.6	255.7	252.4	249.0	248.6	259.1
276.0	301.3	357.6	417.4	483.3	550.3	606.9	669.0	716.8
768.4	818.2	858.7	877.7	861.8	843.9	859.2	868.5	862.6
822.8	775.9	735.1	700.2	669.3	640.8	613.9	589.1	566.4
545.5	526.2	508.3	491.8	476.4	461.8	448.6	436.3	424.9
414.2	404.2	394.9	386.2	377.9	370.2	362.9	356.1	350.2
344.2	338.5	333.2						

* TOWN CREEK, ALA. (141 SQ. MI)   03/14/64   STORM   STUDY

1.0 141.0 121 -1 1

1.0

266.3	265.2	264.2	263.2	262.1	261.2	260.2	259.2	257.0
256.1	255.1	254.2	253.3	252.4	251.6	250.7	249.7	248.8
247.9	247.1	247.5	246.7	245.8	245.0	244.2	243.3	242.5
241.7	240.9	241.1	247.9	267.6	348.5	900.6	1840.8	2984.7
4166.4	4955.4	5691.6	6292.7	6975.9	7673.9	8283.4	8594.8	8291.0
7754.1	7640.2	7622.4	7560.1	7000.7	6246.7	5458.7	4773.2	4251.4
3874.0	3572.6	3294.1	3027.8	2800.1	2610.5	2436.3	2271.7	2138.4
2036.5	1944.7	1846.1	1738.8	1635.9	1543.6	1459.7	1384.0	1315.2
1252.5	1195.1	1142.5	1094.2	1049.5	1008.3	970.2	934.8	901.4
870.9	842.5	816.1	791.4	768.4	746.9	726.9	707.8	690.3
673.9	658.5	644.6	631.1	618.5	606.6	595.5	585.0	575.1
565.9	557.1	548.9	541.2	533.9	526.6	520.0	513.9	508.1
502.6	497.3	492.4	487.7	482.9	478.7	474.6	470.8	467.6
464.0	460.7	457.4						

* TOWN CREEK, ALA. (141 SQ. MI)   05/03/64   STORM   STUDY

1.0 141.0 121 -1 1

1.0

379.4	377.9	376.3	374.9	373.4	372.0	370.6	369.2	367.0
365.7	364.4	363.1	361.8	360.5	359.2	358.0	356.5	355.3
354.1	352.9	352.5	351.3	350.1	348.9	347.7	346.6	345.4
344.3	343.1	342.0	340.9	341.1	348.5	348.5	354.2	369.6
393.3	441.6	689.2	1356.0	2330.1	3412.2	4360.6	5050.1	5673.6
6261.8	6851.7	7382.6	7729.9	7695.1	7237.5	6809.2	6705.1	6633.8
6305.5	5612.9	4813.6	4105.3	3527.8	3063.9	2693.8	2384.9	2134.2
1926.8	1753.9	1609.2	1487.1	1383.1	1294.9	1217.7	1150.4	1091.2
1038.9	992.4	950.6	913.0	879.0	848.0	819.7	793.7	768.7
746.7	726.3	707.4	689.9	673.6	658.4	644.2	630.6	618.2
606.5	595.7	586.6	577.0	568.0	559.5	551.5	544.0	536.9
530.2	523.8	517.9	512.2	506.8	501.0	496.2	491.6	487.2
483.1	479.1	475.3	471.7	468.0	464.7	461.5	458.4	456.2
453.4	450.7	448.1						

* TOWN CREEK, ALA. (141 SQ. MI)   08/15/64   STORM   STUDY

1.0 141.0 121 -1 1

1.0

53.2	53.0	52.9	52.7	52.6	52.4	52.2	52.1	51.1
51.0	50.8	50.6	50.5	50.3	50.2	50.0	49.9	49.7
49.6	49.4	50.1	49.9	49.7	49.6	49.4	49.3	49.1
49.0	48.8	48.7	48.6	48.4	47.0	47.6	49.6	61.5
95.3	175.3	282.4	395.1	502.7	557.8	612.2	657.8	708.9
754.2	785.9	787.2	727.7	659.4	655.1	648.8	625.2	548.4
467.6	402.4	350.6	307.2	273.3	246.7	225.9	209.5	196.8
186.8	181.7	178.2	174.3	170.2	171.6	169.1	167.1	165.4
163.8	162.4	161.2	160.2	159.2	158.2	157.4	156.7	154.7
154.0	153.3	152.6	151.9	151.2	150.6	150.0	149.4	148.9
148.3	147.8	148.6	148.1	147.6	147.1	146.6	146.2	145.7
145.3	144.8	144.4	143.9	143.5	142.4	141.9	141.5	141.1
140.6	140.2	139.8	139.3	138.9	138.5	138.0	137.6	137.9
137.5	137.0	136.6						

YEARLY STATISTICAL SUMMARY

	MONTHLY		DAILY	
	REFERENCE	SIMULATED	REFERENCE	SIMULATED
MEAN	9914.90	10085.50	325.06	330.65
MAXIMUM	32757.35	34005.84	5430.90	6017.22
VARIANCE	110596272.00	117735280.00	429042.81	601067.06
STANDARD DEVIATION	10516.48	10850.59	655.01	775.29
SUM OF (REFERENCE - SIMULATED)	-2047.31		-2047.32	
ROOT SUM SQUARE	2630.77		3268.44	
SUM SQUARED	0.39		54.14	
SUM SQUARED (IBM METHOD)	0.31		48.38	
CORRELATION COEFFICIENT	0.9979		0.9855	

SUMMARY OF MONTHLY AND ANNUAL TOTALS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
PRECIPITATION	0.100	4.580	3.790	6.320	3.570	11.240	9.140	3.670	3.810	7.010	3.090	1.910	58.230 IN
EVP/TRAN-NET	0.317	1.106	0.412	0.451	1.034	1.584	2.583	3.646	3.082	4.368	3.320	1.810	23.714 IN
-POTENTIAL	2.296	1.155	0.412	0.451	1.034	1.584	2.772	4.753	3.836	5.024	4.545	2.891	30.753 IN
SURFACE RUNOFF	0.000	0.347	0.123	3.431	0.834	5.921	3.314	1.405	0.549	1.337	0.232	0.015	17.510 IN
INTERFLOW	0.0	0.0	0.010	0.306	0.268	0.917	1.017	0.214	0.000	0.043	0.0	0.0	2.774 IN
BASE FLOW	0.000	0.212	0.652	1.490	1.230	2.133	2.346	1.315	0.564	1.063	0.530	0.131	11.666 IN
STREAM EVAP.	0.000	0.001	0.000	0.000	0.001	0.002	0.003	0.005	0.004	0.005	0.005	0.003	0.028 IN
TOTAL RUNOFF(SIM)	0.000	0.558	0.785	5.227	2.331	8.969	6.674	2.929	1.109	2.438	0.758	0.144	31.922 IN
TOTAL RUNOFF(REF)	0.0	0.370	0.791	4.798	2.434	8.640	6.683	3.248	1.100	2.269	0.861	0.188	31.382 IN

REFERENCE TOTALS	0.0	1401.6	3000.0	18189.9	9228.8	32757.4	25336.6	12314.6	4170.2	8604.3	3264.1	711.6	118978.8 CFS
SIMULATED TOTALS	0.0	2114.8	2978.0	19815.4	8837.7	34005.8	25302.3	11104.3	4206.3	9244.3	2873.1	544.3	121026.1 CFS

BALANCE -0.0117 INCHES

MONTHLY FLOW CORRELATION COEFFICIENT 0.9979
MEAN DAILY FLOW CORRELATION COEFFICIENT 0.9855

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

MEAN DAILY REFERENCE FLOWS (CFS)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
1	0.0	8.9	16.0	512.6	289.9	209.0	363.6	363.1	73.4	94.5	132.8	50.6	
2	0.0	5.0	18.0	254.0	253.9	1585.9	337.2	2015.6	66.6	94.6	123.4	47.1	
3	0.0	1.3	19.5	204.8	232.2	2093.4	313.2	3765.1	61.8	95.6	114.8	43.9	
4	0.0	17.7	17.7	185.5	215.2	506.7	555.8	733.0	57.3	90.9	106.7	40.5	
5	0.0	427.9	16.7	171.8	233.4	1563.6	517.5	490.4	53.1	82.7	99.0	37.8	
6	0.0	82.6	15.5	295.2	371.3	451.0	1834.9	421.9	510.7	76.9	91.8	35.1	
7	0.0	71.9	14.4	440.9	280.4	338.9	3055.8	385.3	272.0	73.8	85.2	32.6	
8	0.0	67.1	29.3	268.6	237.4	339.3	1928.4	356.2	159.7	94.2	79.3	30.3	
9	0.0	62.5	24.6	2523.1	215.9	373.9	661.6	330.6	144.4	86.9	73.6	28.1	
10	0.0	57.9	24.2	480.3	200.3	1077.2	499.9	307.1	133.1	332.4	68.1	26.1	
11	0.0	54.0	76.8	305.8	187.3	358.1	443.7	284.8	123.6	186.6	63.4	24.3	
12	0.0	50.2	166.4	276.5	173.9	283.2	567.6	264.6	114.9	880.9	59.0	22.3	
13	0.0	46.7	138.5	267.5	162.8	254.6	2702.8	245.2	560.7	770.6	54.8	20.7	
14	0.0	43.5	173.4	248.1	152.8	3832.7	1845.3	227.5	151.9	368.6	51.0	19.2	
15	0.0	40.4	159.7	231.1	943.0	3175.9	708.1	211.0	122.6	309.8	288.0	17.9	
16	0.0	37.4	149.3	215.3	1268.7	847.6	540.5	195.8	112.7	284.3	337.9	16.7	
17	0.0	34.7	139.3	200.3	303.4	512.8	480.4	181.7	104.7	261.3	153.5	15.8	
18	0.0	32.4	129.9	186.2	680.9	427.1	441.8	168.8	97.2	242.7	141.2	16.3	
19	0.0	30.1	120.9	179.0	438.4	407.4	408.9	156.6	90.3	225.1	131.0	14.4	
20	0.0	28.0	112.5	321.0	290.3	446.9	379.0	145.3	83.8	1203.4	121.7	13.0	
21	0.0	26.0	104.6	240.6	248.9	536.8	352.3	134.9	78.0	686.6	113.3	11.8	
22	0.0	24.3	107.7	197.3	227.1	411.1	326.3	125.1	72.3	295.9	105.1	11.3	
23	0.0	22.6	190.2	178.4	210.1	350.4	331.8	116.2	89.2	261.3	98.0	10.4	
24	0.0	20.9	160.4	2377.4	195.1	319.3	573.0	107.8	204.8	240.2	91.0	9.5	
25	0.0	19.2	145.4	5271.7	249.8	3855.7	1114.5	100.2	124.5	222.8	84.7	8.9	
26	0.0	18.1	134.8	582.2	262.1	5430.9	1020.6	93.0	114.8	207.5	78.8	8.5	
27	0.0	16.8	125.4	379.6	216.0	928.5	1408.4	86.3	108.9	192.2	73.2	7.9	
28	0.0	15.6	116.7	328.9	248.9	556.3	721.4	81.3	101.6	178.5	67.9	7.0	
29	0.0	20.6	108.5	301.1	239.4	467.0	498.8	79.7	94.2	166.0	63.0	30.3	
30	0.0	17.3	100.9	278.7		424.2	403.5	72.1	87.4	154.5	58.5	53.3	
31	0.0		142.8	286.4		392.0		68.5		143.0	54.4		
REFERENCE TOTALS	0.0	1401.6	3000.0	18189.9	9228.8	32757.4	25336.6	12314.6	4170.2	8604.3	3264.1	711.6	118978.8 CFS

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

M E A N D A I L Y S I M U L A T E D F L O W S (CFS)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
1	0.0	10.5	12.7	1028.8	235.0	165.1	245.4	255.5	53.3	69.3	89.8	35.8	
2	0.0	5.6	14.7	214.0	182.3	2029.4	227.7	2323.0	47.7	69.7	83.6	33.3	
3	0.0	1.1	16.0	165.3	162.4	2336.8	211.6	4217.8	44.3	71.9	77.7	31.0	
4	0.0	37.5	14.3	149.8	149.5	415.5	639.0	526.8	41.1	68.5	72.3	28.6	
5	0.0	1302.5	13.5	138.9	194.6	1858.2	476.6	341.1	38.0	61.0	67.1	26.8	
6	0.0	82.7	12.4	502.7	446.5	311.2	2706.3	292.1	1055.9	56.7	62.1	24.8	
7	0.0	56.3	11.6	660.1	235.9	241.0	3257.8	266.6	337.7	54.8	57.7	23.0	
8	0.0	52.6	32.7	215.5	180.3	270.5	1867.6	246.7	102.2	75.3	53.8	21.4	
9	0.0	49.1	20.8	3244.2	160.4	315.4	462.1	229.1	95.3	67.0	49.9	19.8	
10	0.0	45.5	19.9	374.5	148.0	1174.6	341.5	213.1	88.5	605.5	46.1	18.4	
11	0.0	42.4	98.4	217.6	138.6	268.7	302.1	197.7	82.2	212.8	43.0	17.2	
12	0.0	39.5	278.1	201.0	128.7	205.3	563.2	183.9	76.5	2068.1	39.9	15.6	
13	0.0	36.7	120.6	198.2	120.9	183.8	3427.9	170.4	684.6	1063.7	37.1	14.6	
14	0.0	34.2	152.8	183.3	115.2	4387.4	1750.5	158.1	107.5	233.4	34.6	13.5	
15	0.0	31.8	137.7	170.8	1271.5	3898.0	490.4	146.7	80.2	202.0	506.1	12.6	
16	0.0	29.4	128.8	159.4	1474.6	655.4	373.5	136.2	74.3	187.4	537.9	11.8	
17	0.0	27.2	120.3	148.4	203.7	363.9	332.2	126.5	69.1	172.2	109.9	11.2	
18	0.0	25.4	112.3	138.1	1032.1	298.7	305.7	117.5	64.0	160.1	99.6	12.0	
19	0.0	23.7	104.6	136.4	371.6	294.7	283.2	109.1	59.5	148.4	92.4	10.3	
20	0.0	22.0	97.4	419.6	208.6	382.7	262.5	101.3	55.3	1489.5	85.8	9.2	
21	0.0	20.4	90.6	206.2	174.4	516.6	244.4	94.0	51.5	718.7	80.0	8.3	
22	0.0	19.1	104.7	154.5	158.2	306.6	226.4	87.2	47.6	195.8	74.2	8.0	
23	0.0	17.7	284.6	137.3	146.2	253.9	264.9	81.0	82.3	175.4	69.2	7.4	
24	0.0	16.4	144.0	3144.5	135.8	230.2	626.4	75.2	329.9	162.0	64.2	6.7	
25	0.0	15.1	128.2	6017.2	221.8	4865.6	1289.7	70.0	87.5	150.5	59.8	6.3	
26	0.0	14.2	118.6	406.0	240.4	5904.3	1192.7	65.0	78.8	140.4	55.7	6.1	
27	0.0	13.2	110.4	253.8	168.7	636.0	1689.0	60.2	75.2	129.9	51.7	5.7	
28	0.0	12.3	102.8	220.8	222.4	372.2	582.1	56.9	70.4	120.7	47.9	4.9	
29	0.0	17.0	95.6	202.4	209.3	314.1	372.8	56.6	65.1	112.3	44.4	36.9	
30	0.0	13.8	88.9	187.6		285.7	287.0	50.7	60.5	104.6	41.3	63.1	
31	0.0		190.2	218.1		264.4		48.4		96.8	38.4		
SIMULATED TOTALS	0.0	2114.8	2978.0	19815.4	8837.7	34005.8	25302.3	11104.3	4206.3	9244.3	2873.1	544.3	121026.1 CFS

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
STORAGES-UZS	0.0	0.203	0.420	0.360	0.330	0.133	0.110	0.227	0.024	0.0	0.0	0.306	IN
LZS	0.183	2.859	4.492	5.281	5.647	6.204	6.085	3.826	3.613	3.722	2.937	2.613	IN
IFS	0.0	0.0	0.019	0.006	0.001	0.0	0.000	0.0	0.0	0.0	0.0	0.0	IN
GWS	0.000	0.048	0.562	0.696	0.580	0.912	0.939	0.175	0.212	0.338	0.136	0.111	IN
INDICES- UZC	0.295	0.250	0.250	0.250	0.250	0.250	0.250	0.294	0.250	0.297	0.309	0.250	
BFNX	0.016	0.130	0.866	1.381	1.335	2.039	2.284	1.124	0.807	0.983	0.581	0.334	
SIAM	0.983	0.865	0.718	0.684	0.774	0.868	1.000	1.124	1.109	1.157	1.154	1.064	

DAILY FLOW DURATION AND ERROR TABLE

FLOW INTERVAL	CASES	AV.ERROR	AVR. ABS. ERROR	STANDARD ERROR
0.0-	31.0	0.0	0.00	0.00
1.0-	1.0	-0.2	0.21	
1.6-	0.0			
2.7-	0.0			
4.5-	2.0	-0.7	1.37	1.94
7.4-	8.0	-2.3	2.69	1.63
12.2-	20.0	-2.7	4.68	5.34
20.1-	19.0	-5.0	6.09	3.94
33.1-	17.0	-10.5	11.64	5.91
54.6-	37.0	-18.9	20.03	8.89
90.0-	54.0	-28.2	30.00	14.92
148.4-	53.0	-40.1	53.61	41.54
244.7-	57.0	-55.0	94.91	89.79
403.4-	34.0	-25.3	167.45	235.95
665.1-	12.0	117.8	292.44	408.09
1096.6-	6.0	281.0	280.98	93.23
1808.0-	8.0	435.0	473.89	386.62
2981.0-	5.0	588.3	588.27	301.79
4914.8-	2.0	609.5	609.48	192.39
8103.1-	0.0			
13359.7-	0.0			
22026.5-	0.0			
	366.0	5.6	91.65	1791.97

CORRELATION COEFFICIENT (DAILY) 0.9855

TWENTY HIGHEST CLOCKHOUR RAINFALL EVENTS IN THE WATER YEAR
0.900 0.860 0.710 0.680 0.650 0.630 0.600 0.600 0.570 0.550 0.530 0.530 0.500 0.470 0.440 0.410 0.390 0.390 0.370 0.370

TWENTY HIGHEST CLOCKHOUR OVERLAND FLOW RUNOFF EVENTS IN THE WATER YEAR
0.738 0.684 0.564 0.557 0.444 0.400 0.369 0.343 0.330 [illegible]

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.)　　WY 64　STUDY　S059 *

DAILY SOIL MOISTURE

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1	0.4	0.8	2.9	4.6	5.3	5.7	6.2	6.1	3.8	3.7	3.6	2.9
2	0.4	0.9	2.9	4.6	5.3	5.7	6.2	6.2	3.8	3.7	3.5	2.8
3	0.4	0.9	2.9	4.6	5.3	5.7	6.2	6.2	3.8	3.8	3.5	2.7
4	0.4	2.6	2.9	4.6	5.3	5.8	6.2	6.2	3.7	3.8	3.4	2.7
5	0.4	3.0	2.9	4.6	5.4	5.8	6.3	6.2	3.7	3.7	3.4	2.6
6	0.3	3.1	2.9	4.7	5.4	5.8	6.3	6.1	4.0	3.6	3.3	2.6
7	0.3	3.1	2.9	4.7	5.4	5.8	6.3	6.0	4.0	3.7	3.2	2.5
8	0.3	3.1	3.1	4.8	5.4	5.8	6.3	5.9	4.0	3.8	3.1	2.4
9	0.3	3.1	3.1	4.9	5.4	5.8	6.3	5.8	4.0	3.8	3.0	2.4
10	0.3	3.1	3.2	4.9	5.4	5.8	6.3	5.7	3.9	4.0	3.0	2.3
11	0.3	3.1	3.7	4.9	5.4	5.8	6.3	5.6	3.8	4.0	2.9	2.3
12	0.3	3.1	3.8	4.9	5.4	5.8	6.4	5.6	3.8	4.4	2.9	2.2
13	0.3	3.1	4.0	4.9	5.4	5.9	6.5	5.5	3.9	4.4	2.8	2.2
14	0.3	3.1	4.0	4.9	5.4	6.0	6.5	5.4	3.9	4.4	2.7	2.1
15	0.3	3.1	4.0	4.9	5.5	6.0	6.5	5.2	3.9	4.3	3.5	2.0
16	0.3	3.0	4.0	4.9	5.5	6.0	6.5	5.1	3.8	4.3	3.6	2.0
17	0.3	3.0	4.0	4.9	5.5	6.0	6.5	5.0	3.7	4.2	3.6	2.0
18	0.3	3.0	4.0	4.9	5.5	6.0	6.4	4.9	3.6	4.2	3.6	2.0
19	0.2	2.9	4.0	5.0	5.5	6.0	6.3	4.8	3.5	4.0	3.6	2.0
20	0.2	2.9	4.0	5.0	5.5	6.1	6.2	4.7	3.4	4.3	3.5	2.0
21	0.2	2.9	4.0	5.0	5.5	6.1	6.2	4.6	3.4	4.3	3.5	1.9
22	0.2	2.9	4.2	5.0	5.5	6.1	6.1	4.5	3.3	4.3	3.4	1.9
23	0.2	2.9	4.3	5.0	5.5	6.1	6.0	4.4	3.6	4.3	3.4	1.9
24	0.2	2.9	4.3	5.2	5.5	6.1	6.0	4.2	3.6	4.2	3.3	1.8
25	0.2	2.8	4.3	5.2	5.6	6.2	6.0	4.2	3.6	4.1	3.3	1.8
26	0.2	2.8	4.3	5.2	5.6	6.2	6.0	4.1	3.6	4.1	3.2	1.7
27	0.2	2.8	4.3	5.2	5.6	6.2	6.1	4.0	3.6	4.0	3.2	1.7
28	0.2	2.8	4.3	5.2	5.6	6.2	6.1	3.9	3.6	3.9	3.2	1.7
29	0.2	2.9	4.3	5.2	5.6	6.2	6.1	3.9	3.6	3.8	3.1	2.6
30	0.2	2.9	4.3	5.2		6.2	6.1	3.8	3.6	3.8	3.0	2.6
31	0.2		4.5	5.3		6.2		3.8		3.7	2.9	

MULTI= 0　CONOPT(10)= 0　CONOPT(15)= 0　IBFLAG= 0　KWMAIN= 2

MULTI= 0　CONOPT(10)= 0　CONOPT(15)= 0　IBFLAG= 13　KWMAIN= 3

IDFLAG= 0　IENDFG= 0　ISFLAG= 13　MAIN= 3

TOWN CREEK, ALA. (141. SQ.MI.) STORM 11/05/63 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	689.7	2232.5	1543.30	223.8	
ANNUAL PEAK(CFS)		11684.1			13.2
PEAK(HR)	33	33	0	0.0	
RUNOFF(IN)	0.18	0.40	0.23	129.9	

TOWN CREEK, ALA. (141. SQ.MI.) STORM 01/25/64 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	9839.7	11671.9	1832.30	18.6	
ANNUAL PEAK(CFS)		11684.1			15.7
PEAK(HR)	53	52	-1	1.9	
RUNOFF(IN)	2.31	2.62	0.31	13.4	

TOWN CREEK, ALA. (141. SQ.MI.) STORM 02/15/64 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	2883.9	4023.6	1140.10	39.5	
ANNUAL PEAK(CFS)		11684.1			9.8
PEAK(HR)	24	24	0	0.0	
RUNOFF(IN)	0.96	1.15	0.19	19.9	

TOWN CREEK, ALA. (141. SQ.MI.) STORM 03/14/64 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	8594.8	10033.7	1439.20	16.7	
ANNUAL PEAK(CFS)		11684.1			12.3
PEAK(HR)	44	44	0	0.0	
RUNOFF(IN)	2.27	2.50	0.23	10.1	

TOWN CREEK, ALA. (141. SQ.MI.) STORM 05/03/64 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	7729.9	9399.9	1670.10	21.6	
ANNUAL PEAK(CFS)		11684.1			14.3
PEAK(HR)	49	49	0	0.0	
RUNOFF(IN)	1.94	2.02	0.08	4.1	

TOWN CREEK, ALA. (141. SQ.MI.) STORM 08/15/64 STUDY S059 *

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	787.2	1573.4	786.80	99.9	
ANNUAL PEAK(CFS)		11684.1			6.7
PEAK(HR)	48	48	0	0.0	
RUNOFF(IN)	0.26	0.34	0.08	32.8	

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

TOTAL DAILY STREAMFLOW STATISTICAL SUMMARY FOR 1 WATER YRS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF O-S	ROOT SUM SQUARE	CORR COEFF
REFERENCE WY 64	325	5430	429042	655			
SIMULATED	330	6017	601067	775	-2047	3268	0.99

MODEL PARAMETERS	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
	4.0	3.5	0.20	0.20	0.20	0.25	0.15	0.94	0.94	0.93	0.050	16	31.04	*****	141.0	4800.0	0.50	0.18

*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

TOTAL MONTHLY STREAMFLOW STATISTICAL SUMMARY FOR 1 WATER YRS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF O-S	ROOT SUM SQUARE	DRIEST MONTH ** (CFS)	CORR COEFF
REFERENCE WY 64	9914	32757	110596272	10516			0 (1)	
SIMULATED	****	34005	117735280	10850	-2047	2630	0 (1)	1.00

MODEL PARAMETERS	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
	4.0	3.5	0.20	0.20	0.20	0.25	0.15	0.94	0.94	0.93	0.050	16	31.04	*****	141.0	4800.0	0.50	0.18

**- THE MONTHS OF A GIVEN WATER YEAR ARE NUMBERED AS FOLLOWS:

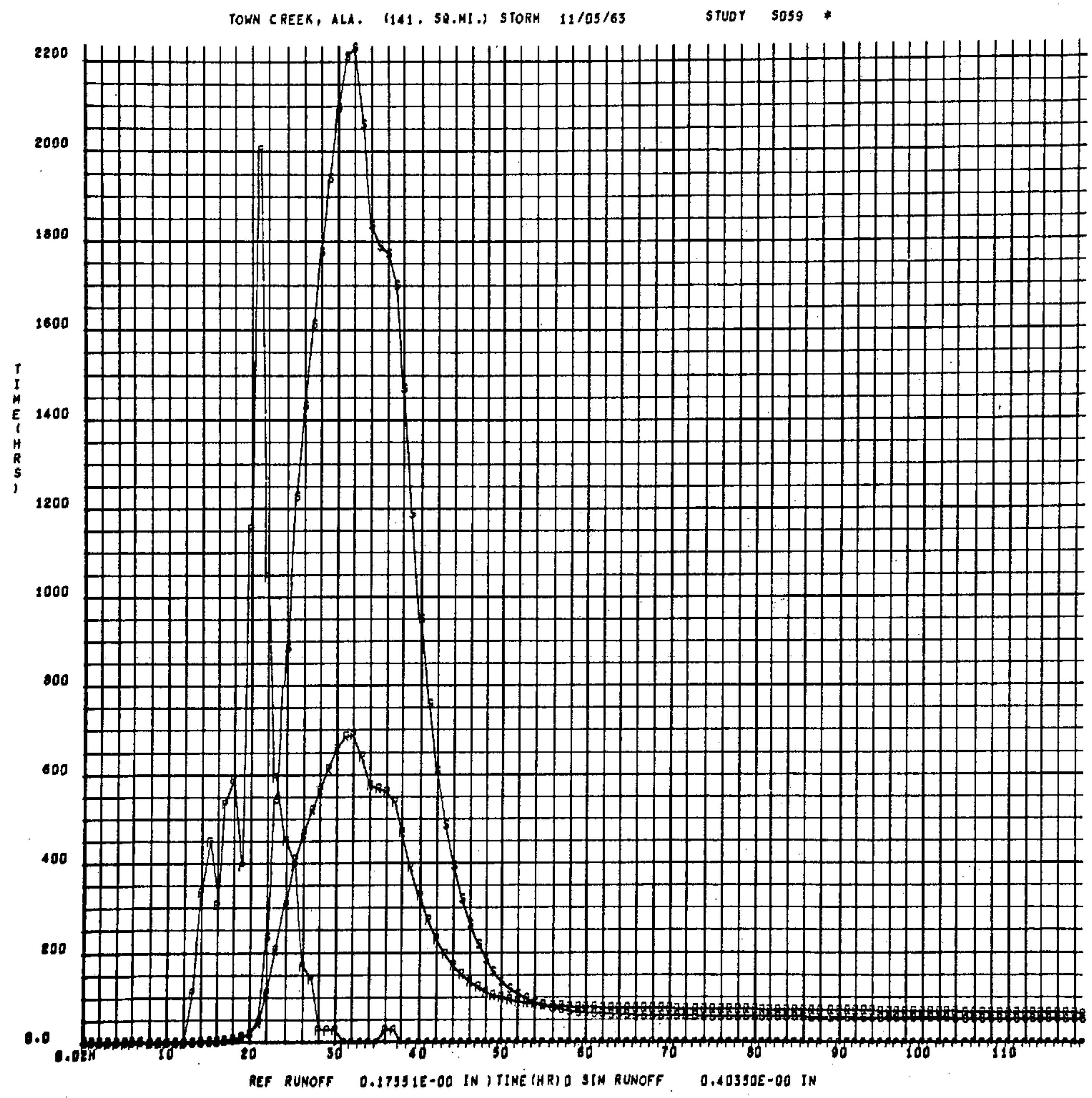
NO	1	2	3	4	5	6	7	8	9	10	11	12
MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT

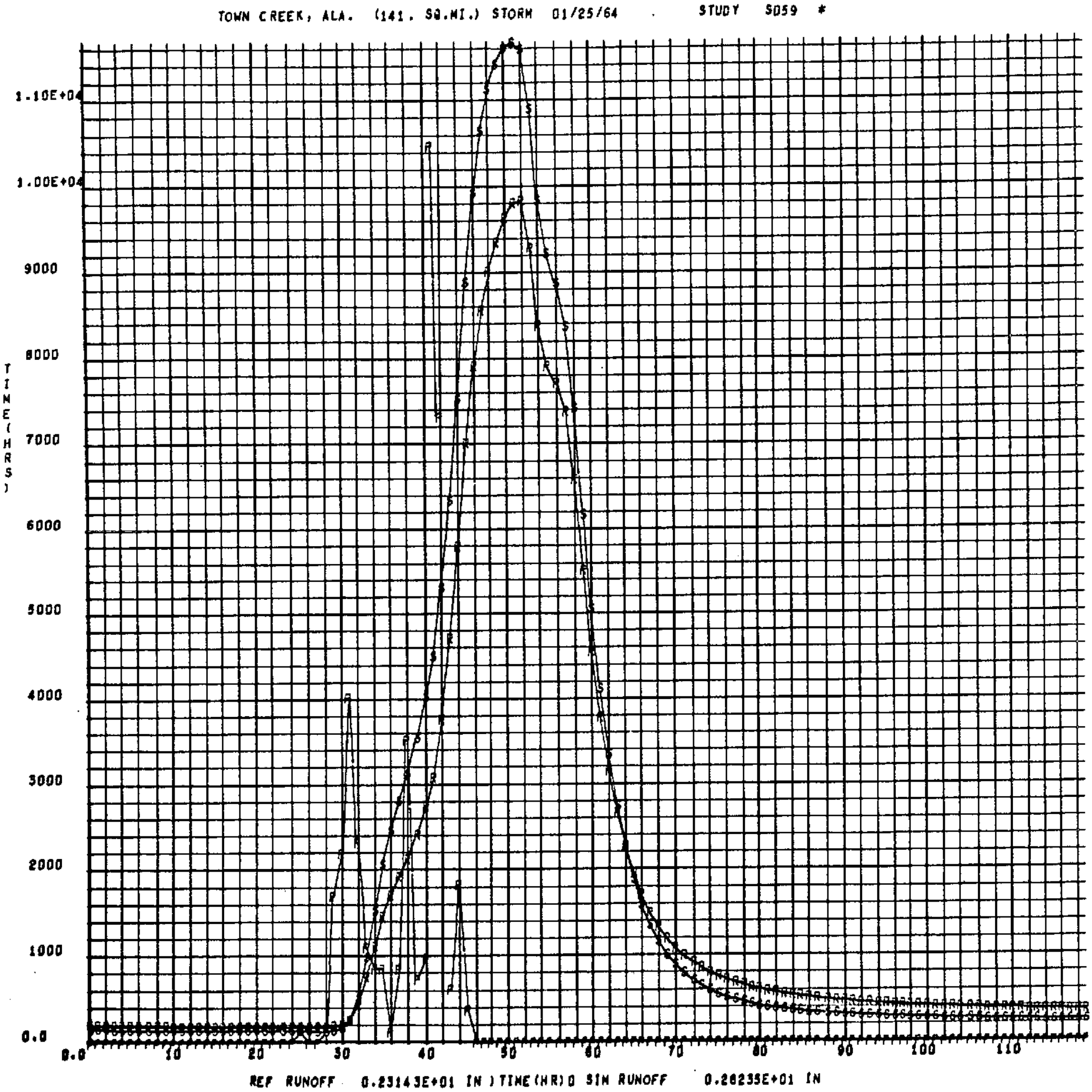
*TOWN CREEK NR GERALDINE, AL. (141 SQ MI.) WY 64 STUDY S059 *

TOTAL STORM ANALYSIS SUMMARY FOR 1 WATER YRS

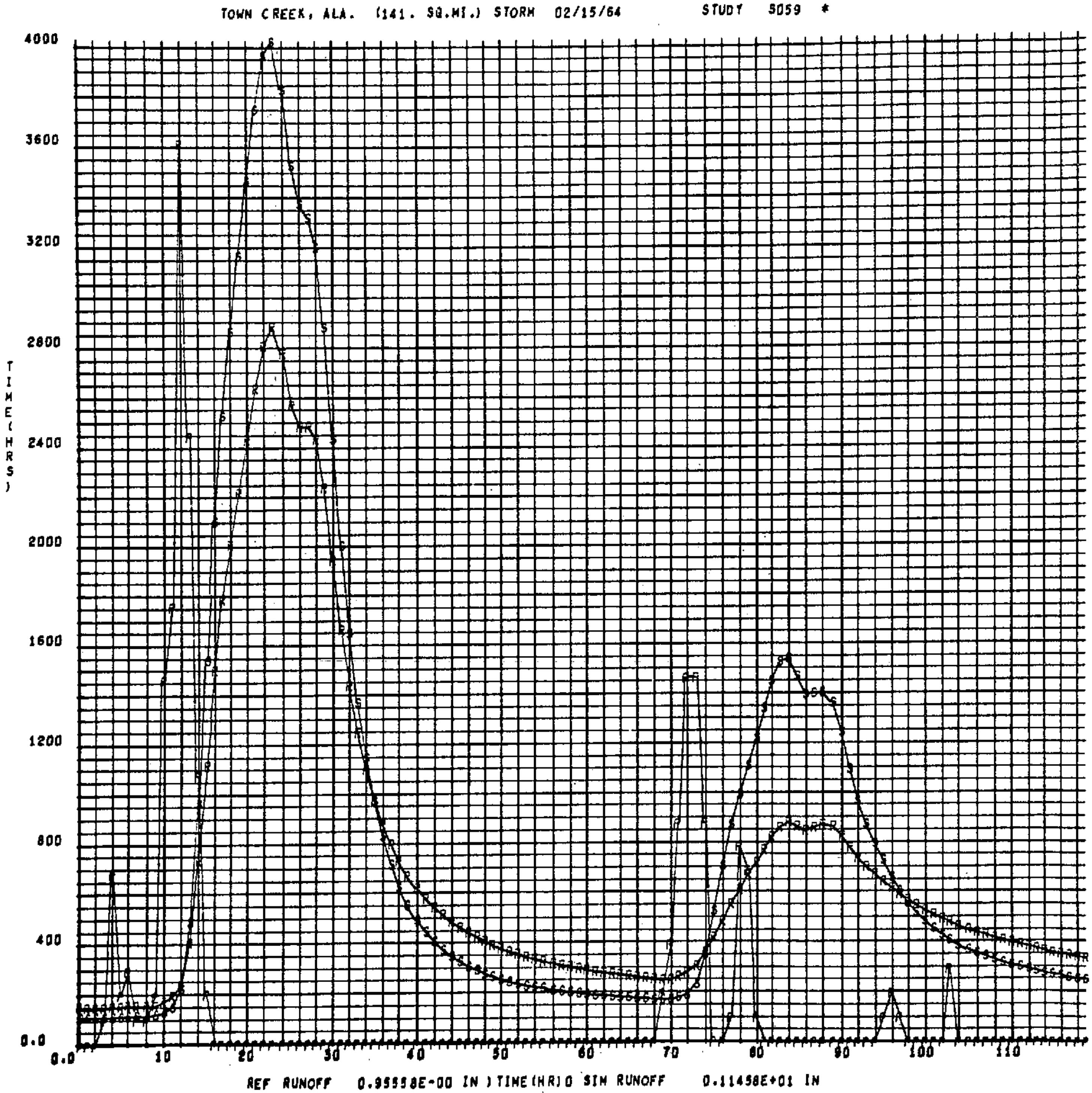
	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)
	11/05/63			01/25/64			02/15/64			03/14/64			05/03/64			08/15/64		
REFERENCE WY 64	689	33	0.18	9839	53	2.31	2883	24	0.96	8594	44	2.27	7729	49	1.94	787	48	0.26
SIMULATED	2232	33	0.40	11671	52	2.62	4023	24	1.15	10033	44	2.50	9399	49	2.02	1573	48	0.34

MODEL	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
PARAMETERS	4.0	3.5	0.20	0.20	0.20	0.25	0.15	0.94	0.94	0.93	0.050	16	31.04	*****	141.0	4800.0	0.50	0.18

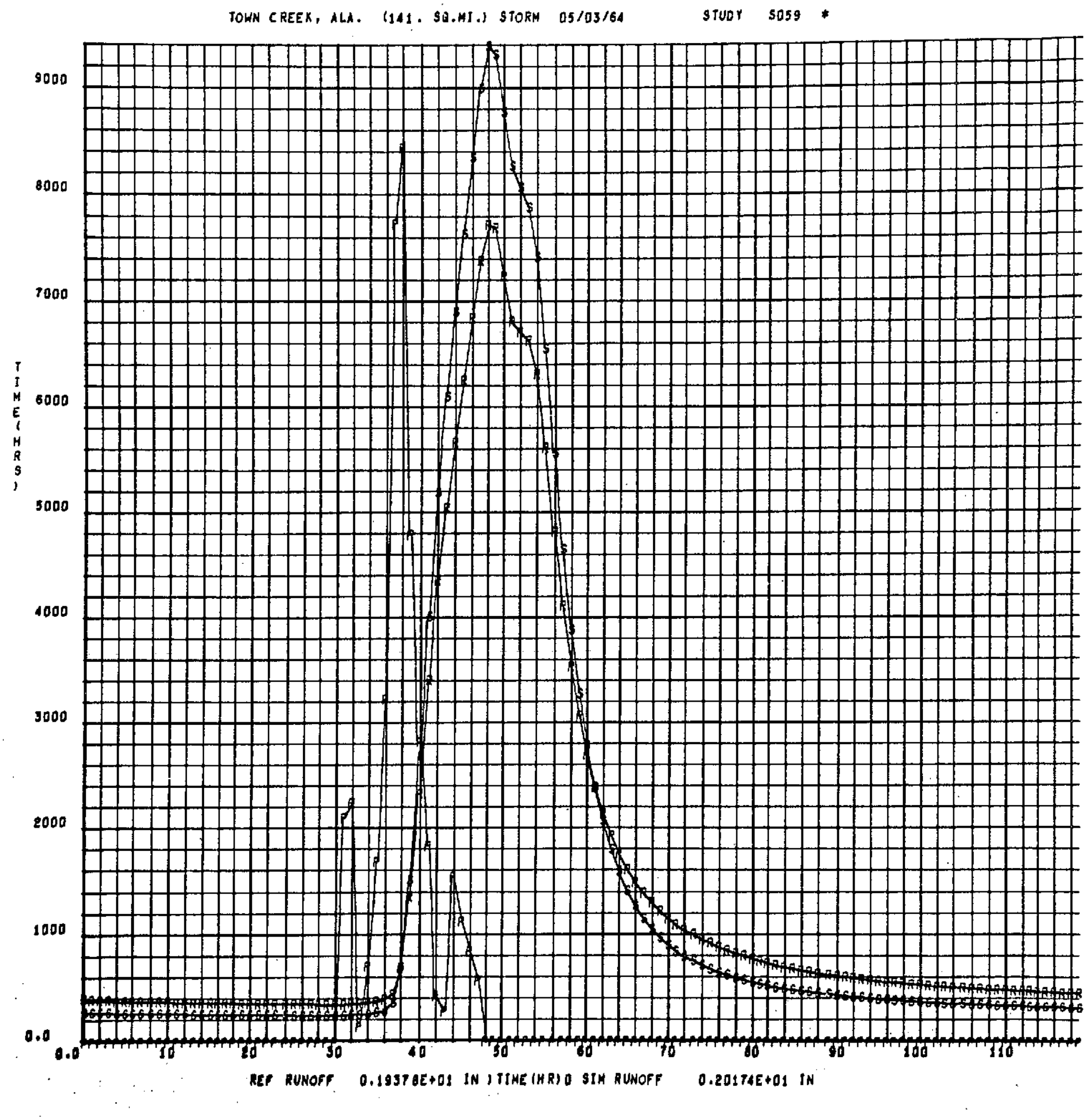

TOWN CREEK, ALA. (141. SQ.MI.) STORM 11/05/63 STUDY 5059 *
TIME(HRS)
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0.0
0.0ZH
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.17351E-00 IN)TIME(HR)0 SIM RUNOFF 0.40350E-00 IN



TOWN CREEK, ALA. (141. SQ.MI.) STORM 01/25/64 . STUDY S059 *
1.10E+04
1.00E+04
9000
8000
7000
6000
5000
4000
3000
2000
1000
0.0
TIME(HRS)
0.0
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.23143E+01 IN) TIME(HR) 0 SIM RUNOFF 0.28235E+01 IN

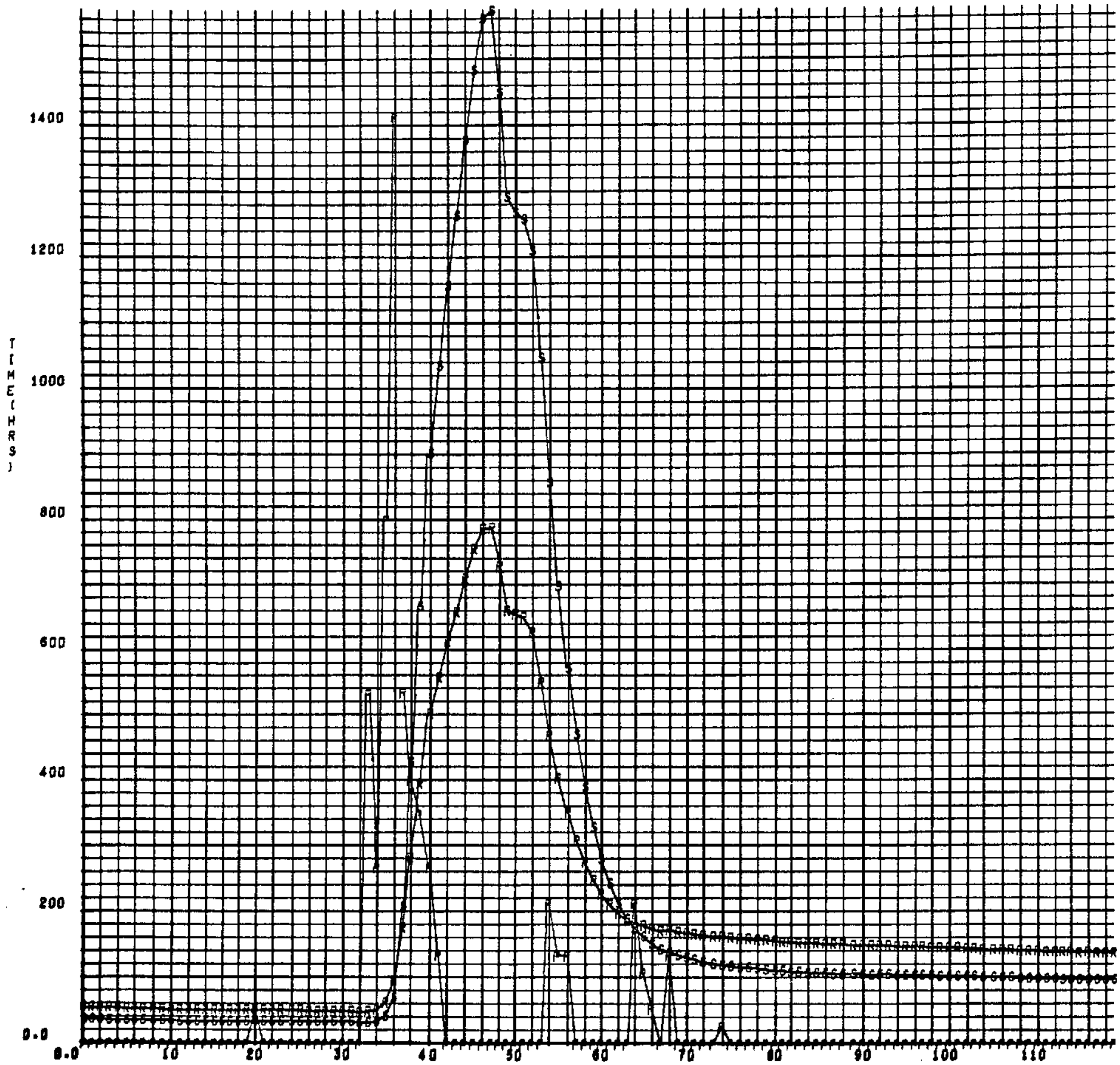


TOWN CREEK, ALA. (141. SQ.MI.) STORM 02/15/64 STUDY 5059 *
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0.0
T I M E (H R S)
0.0
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.95558E-00 IN) TIME(HR)0 SIM RUNOFF 0.11458E+01 IN



PRECEDING PAGE BLANK NOT FILMED

TOWN CREEK, ALA. (141. SQ.MI.) STORM 08/15/64 STUDY 5059 *



REF RUNOFF 0.25510E-00 IN) TIME(HR) 0 SIM RUNOFF 0.33888E-00 IN

APPENDIX B

SAMPLE SIMULATION RUN OUTPUT, SMALL SNOWSHED MODEL

The basin designated "Alamosa Creek above Terrace Reservoir," is in the south central part of Colorado in the Rocky Mountains. The dominant precipitation is winter snow. Moisture accumulates in the snowpack during winter, when streamflow is small but unreadable because the stage height - discharge relationship is affected by icing. Greatest runoff occurs in the spring during snowmelt.

The Alamosa Creek watershed (Figure B-1) was selected as a basis for modeling and sensitivity analysis in the study because it is representative of small mountainous snowsheds yet low enough in altitude so that seasonal effects on its hydrological behavior are pronounced. Additionally, it has previously been the subject of modeling and study by Colorado State University, using the same basic simulation model as was used in the IBM study. Basin descriptive data, model parameters, streamflow and mean basin climatological data for the water year 1958 were provided by CSU.

For the water year 1958, the reference average and peak discharges were 2.24 and 24.8 cubic meters per second respectively. The published 17-year average was 3.25 m^3/s, and the highest recorded discharge was 147.2 m^3/s. The least actual discharge cannot be determined. The total annual mean basin precipitation for the reference year is 85 cm, compared with an annual average estimated at 120 cm. (Note: In a mountainous region, average annual precipitation varies widely for points only a few miles apart; calculation of mean basin precipitation on a long-term or a short-term basis in such a region is hazardous at best.)

The observed daily discharge used in the original model calibration is that recorded by USGS gage 2360, shown in Table B-1.

Page B-4 and subsequent pages of this appendix contain a reproduction of the printout from one simulation run in which the parameter BMIR was perturbed by -50%, from a reference value of 20.0.

Print plots have been omitted in favor of the SC4020 plots at the end of the appendix. In those plots, "R" indicates reference and "S" indicates simulated streamflow.

Area	277 km^2
Minimum Elevation	2628 m
Maximum Elevation	4152 m
Mean Surface Slope	0.340 m/m

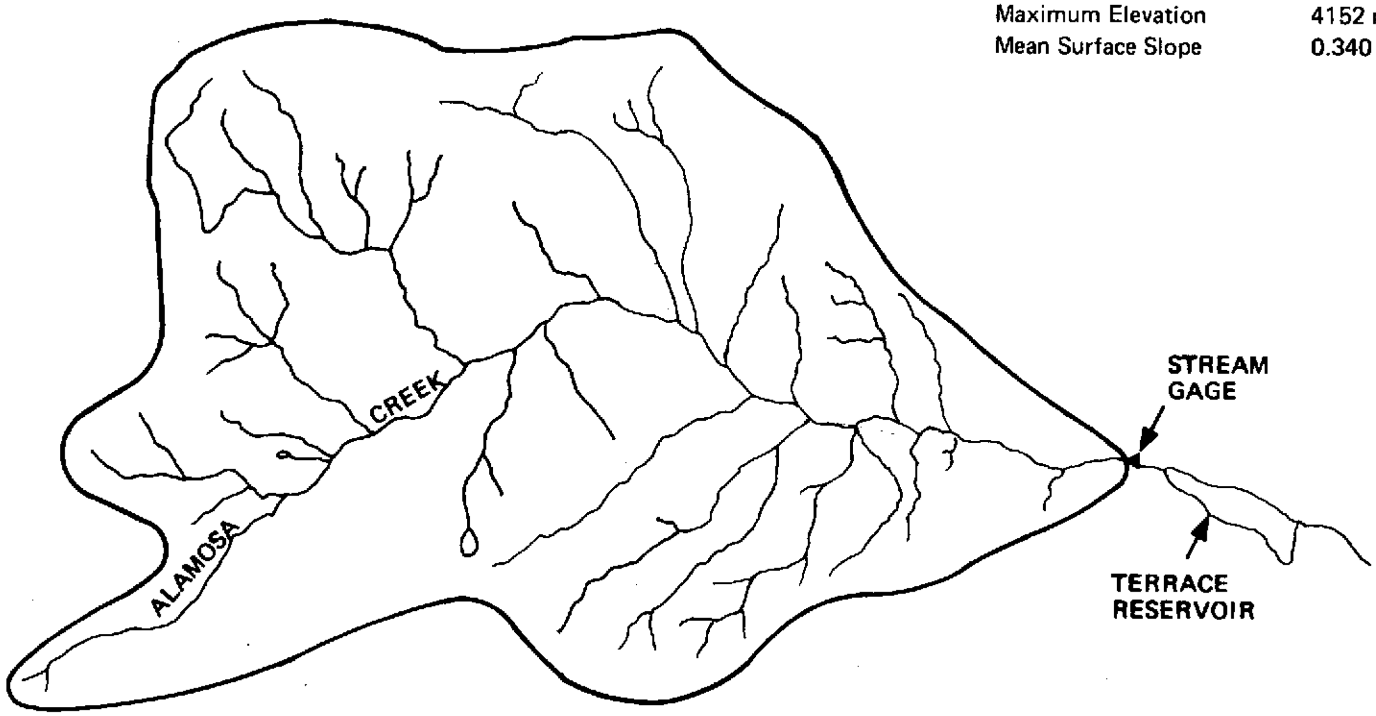


Figure B-1. Alamosa Creek Watershed

Table B-1. Alamosa Creek Observed Discharge Data, WY 1958

RIO GRANDE BASIN

8360. Alamosa Creek above Terrace Reservoir, Colo.

Location.--Lat 37°23', long 106°21', in sec. 8, T. 36 N., R. 6 E., on left bank 3 miles upstream from Terrace Reservoir Dam and 15 miles northwest of Capulin.

Drainage area.--107 sq mi.

Records available.--September 1911 to June 1912 and October 1934 to September 1958 in reports of Geological Survey. April 1915 to October 1919, October 1923 to September 1927, and October 1934 to September 1944 in reports of State engineer. (No winter records most years.) September 1911 to June 1912 published as Rio Alamosa near Monte Vista.

Gage.--Water-stage recorder. Altitude of gage is 8,600 ft (from topographic map). Sept. 29, 1911, to June 4, 1912, staff gage at ranger station 1½ miles upstream at different datum. Apr. 1 to May 6, 1915, staff gage and May 7, 1915, to Sept. 30, 1927, water-stage recorder, near present site at different datum.

Average discharge.--17 years (1923-24, 1940-41, 1943-58), 115 cfs (83,260 acre-ft per year).

Extremes.--Maximum discharge during year, 1,120 cfs May 27 (gage height, 3.32 ft), from rating curve extended above 930 cfs; minimum not determined.
1911-12, 1915-19, 1923-27, 1934-58: Maximum discharge, 5,200 cfs Oct. 5, 1911 (gage height, 11.0 ft, site and datum then in use, from floodmark), from rating curve extended above 1,000 cfs on basis of computation of peak flow over dam about 8 miles upstream; minimum not determined.

Remarks.--Records good except those for periods of ice effect or no gage-height record, which are poor. No diversion above station.

Revisions (water years).--WSP 898: 1911(M).

Rating tables, water year 1957-58, except period of ice effect (gage height, in feet, and discharge, in cubic feet per second)
(Shifting-control method used Apr. 23 to May 5)

Oct. 1 to June 29				June 30 to Sept. 30			
1.0	18	2.5	460	0.8	17	1.6	116
1.3	60	3.0	800	1.0	32	2.0	225
1.6	116	4.0	1,700	1.3	66		
2.0	225						

Discharge, in cubic feet per second, water year October 1957 to September 1958

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	28	30					19	104	720	110	32	23
2	30	31					21	104	712	101	30	23
3	28	32					19	106	652	101	30	23
4	28	32					21	114	619	92	34	23
5	28	32					26	164	586	84	*44	25
6	28	31			(*)		21	228	776	78	42	29
7	28	30					23	305	668	76	37	28
8	28	28					22	365	556	72	34	26
9	27	27					22	390	496	69	31	26
10	26	26	(*)	(*)			19	412	430	*65	27	29
11	24					(*)	*21	442	395	63	30	34
12	26						22	496	360	58	29	29
13	30					18	32	418	325	57	30	94
14	28						23	406	296	52	*30	105
15	30	21	23	18	20		31	412	284	51	34	69
16	28						42	484	292	50	31	*58
17	*28						62	490	284	50	35	51
18	28	(*)					83	593	*268	49	39	46
19	34						102	645	256	51	42	49
20	38						104	682	256	45	44	42
21	38						123	668	250	41	38	39
22	37						132	*760	219	39	61	36
23	39						121	808	196	38	50	34
24	30						102	808	184	36	39	38
25	30	15					110	840	173	38	35	43
26	28					15	114	856	149	39	31	38
27	27					15	130	904	142	39	*30	35
28	28					15	139	840	123	34	30	37
29	28					16	*123	816	121	33	27	35
30	28					17	110	824	118	35	26	34
31	31					22		728		34	26	
Total	917	659	713	558	560	550	1,930	16,212	10,906	1,780	1,070	1,201
Mean	29.6	22.0	23	18	20	17.7	64.3	523	364	57.4	34.5	40.0
Ac-ft	1,820	1,310	1,410	1,110	1,110	1,090	3,830	32,160	21,630	3,530	2,120	2,380

Calendar year 1957: Max 1,400 Min - Mean 182 Ac-ft 131,800
Water year 1957-58: Max 904 Min - Mean 102 Ac-ft 73,840

Peak discharge (base, 670 cfs).--May 19 (9 p.m.) 704 cfs (2.95 ft); May 27 (10 p.m.) 1,120 cfs (3.32 ft); June 6 (7 p.m.) 944 cfs (3.10 ft).

* Discharge measurement made on this day.
Note.--No gage-height record Nov. 22 to Mar. 26 (stage-discharge relation affected by ice during most of period), Mar. 26; discharge estimated on basis of 4 discharge measurements, weather records, and records for nearby stations. Stage-discharge relation affected by ice Nov. 9-21.

```
 SNOW62   *ALAMOSA CREEK NEAR MONTE VISTA,COLO. (107 SQ. MI.) WY 58
            *CONTROL OPTIONS (BALANCE OF DATA VARIES WITH SPECIFIED OPTIONS)
   *(1)  (2)  (3)  (4)  (5)  (6)  (7)   (8) (9)(10)(11)(12) (13)(14)(15)(16)
     0     1    1    1    1    1    1     0   1   0   0   1    0   1   3   1
   * TIME - AREA HISTOGRAM DEFINITION
  *NBTRI  BTRI(1)  (2)   (3)   (4)   (5)   (6)
        6    .056  .198  .199  .240  .281  .026
          * SNOW PARAMETERS
            *FIRR (15)
   .80  .75  .70  .65  .60  .55  .53 .50  .49  .48  .47  .45  .43  .41  .40
            *RICY (37)
   .55  .56  .57  .61  .67  .75  .80  .83  .87  .92  .96  .99  1.0  1.0  .98
   .95  .91  .87  .84  .81  .79  .77  .75  .73  .72  .71  .70  .69  .68  .67
   .65  .64  .62  .60  .57  .56  .55
            *DPSE (37)
   0.0  0.0  0.0  .006  .0116  .0124  .0114  .0102  .0091  .0080  .0070  .0060
   .0052  .0046  .0050  .0070  .0093  .0108  .0123  .0132  .0125  .0100  .06
   .03  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
            *BDDFSM-SPBFLW-SPTWCC-SPM-ELDIE-XDFNS-FEDR--EESI-MRNSM-DSMGH-PXCSA
             .0033  .040  4.00  1.00  1.113  .04  .40  .15  .015  .018  .199
   0.0      * OUTPUT PARAMETER -  RMPF, IF ANY DAILY FLOW EXCEEDS RMPF
   * WATERSHED PARAMETERS - RGPMB - AREA  -  EIMP  -  EWTR
                            1.0     107.       .01       0.006
  * SOIL MOISTURE PARAMETERS
  * VINTMR-BUZC- SUZC - LZC - ETLE - SUBWF - GWETF- SIAC - BMIR - BIVF
    0.15   1.0   1.5   6.0   0.30   0.0    0.0    0.42   10.0   2.9
   * OVERLAND FLOW PARAMETERS - OFSS - OFSL - OFMN - OFMNIS - IFRC
                                0.34   1000.   .35   .025   .60
   *CHANNEL ROUTING AND GROUND WATER PARAMETERS
   *   CSRX - FSRX - CHCAP - EXQPV - BFNLR - BFRC
       0.91    0.94   670.0   0.30   0.90   0.95
   *MOISTURE STORAGE VALUES - GWS  -  UZS - LZS   -  BFNX  -  IFS
                              0.187   0.0   4.0      0.90     0.0
 *       ALAMOSA CREEK ABOVE TERRACE RESERVOIR, NEAR MONTE VISTA, COLO.
  5        *JULDI- NUMBER OF SELECTED HOURLY STORMS
  291 121 111 121 130 121 215 121 265 121
           * LAST TWO DIGITS IN THE CALLNDER YEARS OF THE WATER YEAR TO BE RUN
  57 58    * YEAR1 - YEAR2
 *  ABOVE CARD IS ALPHANUMERIC DATA TO LOCATE STREAMGAGE
 * EVAPORATION DATA
 * AVERAGE DAILY EVAPORATION VALUES OVER 10-DAY PERIODS
    0.081 0.027 0.034 0.040 0.028 0.018 0.019 0.024 0.021          * FALL  57
    0.027 0.024 0.019 0.029 0.032 0.039 0.029 0.040 0.051          * WINTER58
    0.048 0.071 0.082 0.095 0.120 0.153 0.173 0.218 0.235 0.212    * SPRING58
    0.223 0.207 0.118 0.165 0.095 0.124 0.102 0.090 0.098          * SUMMER58
 * MONTHLY PAN COEFICIENTS 1956- 1959
  1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00
 * STREAMFLOW DATA
 * AVERAGE RECORDED STREAMFLOW VALUES DURING DAY IN CFS
    25.63  24.27  24.78  22.49  20.60  19.89  19.05  17.45  16.50  18.07     *OCT
    15.74  20.63  17.86  14.87  13.07  12.14  21.17  12.44  12.94  23.05     *OCT
    26.09  20.50  18.81  18.23  17.46  16.54  16.34  15.04  14.92  14.39     *OCT
    16.28                                                                    *OCT
    18.95  19.57  17.67  17.46  17.22  16.99  16.73  16.46  16.18  15.92     *NOV
    15.66  15.42  15.10  14.97  14.76  14.57  14.40  14.23  14.08  13.94     *NOV
    13.81  13.69  13.58  13.49  13.40  13.32  13.25  13.18  13.10  13.08     *NOV
    17.49  19.80  20.15  20.12  19.95  19.74  19.51  19.28  19.05  18.84     *DEC
    18.64  18.45  18.28  18.12  17.97  17.84  17.72  17.61  17.51  17.42     *DEC
    17.34  17.26  17.20  17.15  17.10  17.06  17.03  17.01  16.99  16.98     *DEC
    16.97                                                                    *DEC
```

```
  16.97  16.98  16.99  17.00  17.02  17.04  17.07  17.10  17.14  17.18     *JAN
  17.22  17.27  17.31  17.37  17.42  17.48  17.54  17.60  17.66  17.73     *JAN
  17.80  17.87  17.94  19.02  18.09  18.17  18.25  18.33  18.40  18.49     *JAN
  18.58                                                                    *JAN
  18.67  18.75  18.84  18.93  19.02  19.11  19.20  19.29  19.39  19.48     *FEB
  19.58  19.67  19.77  19.87  19.96  20.06  20.16  20.26  20.36  20.17     *FEB
  20.23  20.08  20.04  20.08  20.17  20.28  20.40  20.53                   *FEB
  20.66  20.79  20.92  21.05  21.18  21.31  21.44  21.57  21.70  21.82     *MAR
  21.95  22.07  22.19  22.32  22.44  22.56  22.68  22.80  22.92  23.03     *MAR
  23.15  23.26  23.37  23.48  23.59  23.69  23.79  23.89  24.00  24.09     *MAR
  24.18                                                                    *MAR
  24.28  24.37  24.46  24.55  24.64  24.72  24.81  24.89  24.98  25.06     *APR
  25.14  25.22  25.30  24.85  24.30  23.39  22.35  21.27  20.21  19.18     *APR
  18.12  21.61  25.97  25.07  23.27  22.50  22.08  21.84  21.80  21.58     *APR
  24.03  25.36  28.21  49.35  86.02 132.04 205.44 214.58 199.58 201.48     *MAY
 316.83 919.23 679.52 534.95 460.79 430.48 433.22 478.82 527.57 609.11     *MAY
 737.33 749.34 753.09 770.00 765.96 727.57 683.21 640.01 607.3  568.73     *MAY
 532.92                                                                    *MAY
 502.32 474.49 448.84 424.94 418.11 431.72 392.56 369.98 349.72 330.18     *JUN
 312.67 296.22 280.72 266.00 252.14 239.07 226.67 214.91 203.75 192.88     *JUN
 182.85 173.33 164.30 155.74 147.61 139.90 132.59 125.65 119.1  113.22     *JUN
 107.29 101.67  96.33  91.27  86.46  83.50  81.45  73.77  69.69  65.79     *JUL
  62.27  58.93  55.76  52.75  49.89  47.18  44.60  45.81  40.41  37.96     *JUL
  35.87  33.88  31.99  30.20  30.88  30.25  25.40  23.94  23.60  41.33     *JUL
  22.81                                                                    *JUL
  20.49  19.35  23.62  26.31  32.11  28.09  15.07  14.21  12.58  33.31     *AUG
  22.05  19.15  15.10  10.48   9.31  12.88  17.43   7.98  12.91   8.63     *AUG
  19.66  29.37   9.01   8.52   8.02   7.54   7.08   6.64  5.70    5.33     *AUG
   4.96                                                                    *AUG
   4.60   4.26   3.94   5.17  14.59   4.42   2.96   5.07   3.21   5.58     *SEP
   6.64  27.17  39.57  38.66  17.02  16.01  14.67  18.25  19.52  18.84     *SEP
  17.28  16.36  17.89  35.82  18.75  17.82  16.87  16.68  15.20  14.29     *S5P
 * TEMPERATURE DATA FOR 1958 WATER YEAR
 63. 28. 60. 22. 53. 30. 51. 38. 55. 41. 57. 35. 55. 27. 57. 19.       *1
 58. 20. 57. 21. 56. 20. 52. 31. 39. 25. 44. 31. 47. 18. 48. 20.       *2
 48. 30. 40. 21. 46. 28. 42. 26. 46. 22. 36. 23. 46.  3. 46.  5.       *3
 45.  7. 47.  8. 40.  7. 48. 15. 43. 29. 55. 15. 51. 22.               *4
 44. 30. 36. 19. 40. 28. 43. 24. 38. 15. 29. 17. 38. 12. 40. -10.      *1
 40. -6. 35.  5. 39.  6. 39.  9. 39.  5. 39. 12. 33. 11. 35. 10.       *2
 30.  0. 30. -8. 27. -9. 27. -8. 23. -1. 14. -10. 13. -8. 32.  0.      *3
 37. -1. 39. -1. 36. 1. 20. -10. 20. -10. 26. -12.                     *4
 24. -14. 29. -10. 28. -11. 28. -11. 31. 0. 41. 7. 30. -3. 28. 8.      *
 42.  3. 41. -3. 37. -5. 31. -7. 35. -6. 36. -3. 36.  1. 35.  6.       *2
 40.  7. 44.  2. 36.  5. 31. -4. 35. -3. 33.  0. 43. -1. 33.  5.       *3
 32. -4. 32. -6. 35.  2. 27. -7. 32. -1. 36.  2. 37. -11.              *4
 35.  8. 33. 11. 32. 14. 30. 15. 29.  9. 29.  8. 40.  9. 37. 14.       *1
 32. 10. 32.  9. 26. 12. 27.  9. 24. 13. 23.  9. 36.  1. 40. 12.       *2
 35.  9. 27.  9. 19. 11. 19.  1. 26. -7. 24. -1. 20. -9. 27. 12.       *3
 24. 14. 28. 12. 28. 17. 25.  0. 32. 16. 25. 13. 20. -4.               *4
 28. 12. 32.  1. 35. 12. 30. 21. 31. 11. 29.  8. 32.  1. 32.  9.       *1
 27. 20. 28.  4. 25.  5. 27. -3. 26. 15. 25. -2. 32.  7. 38. 11.       *2
 39. 12. 43. 13. 42. 18. 63. 15. 42. 18. 44. 13. 40. 17. 37. 17.       *3
 33. 21. 32. 12. 27.  5. 20. -10.                                      *4
 22. -10. 24. -4. 24. -5. 28.  1. 28. -2. 29.  4. 29. 14. 29.  2.      *1
 25.  6. 27. -8. 27.  4. 24.  1. 30. -4. 24. 10. 26. 12. 30. 19.       *2
 32. 18. 35. 10. 33.  4. 38.  8. 40. 21. 35. 22. 38. 21. 40. 18.       *3
 35. 15. 35. 19. 35.  2. 30. 19. 38.  6. 37.  8. 32. 10.               *4
 33. 11. 28. 18. 29. 19. 28. 14. 28. -3. 38.  1. 37. 20. 30. 20.       *1
 35. 15. 32.  8. 29.  9. 29. 15. 36.  3. 48.  6. 50. 16. 48. 20.       *2
```

```
54. 25. 51. 26. 49. 25. 47. 18. 46. 22. 50. 26. 49. 24. 47. 17.          *3
38. 28. 40. 20. 38. 19. 36. 27. 42. 22. 46. 16.                          *4
42. 21. 48. 20. 50. 26. 56. 25. 57. 25. 58. 29. 57. 35. 51. 24.          *1
52. 18. 55. 21. 55. 23. 50. 32. 51. 21. 53. 25. 56. 21. 55. 25.          *2
63. 23. 62. 26. 63. 27. 64. 28. 64. 26. 62. 27. 64. 27. 69. 28.          *3
66. 33. 68. 30. 68. 29. 70. 27. 69. 35. 65. 27. 63. 29.                  *4
67. 27. 67. 32. 67. 26. 71. 26. 63. 39. 55. 37. 62. 32. 63. 33.          *1
60. 41. 62. 23. 65. 27. 62. 25. 65. 27. 66. 37. 69. 25. 68. 30.          *2
71. 30. 69. 30. 71. 28. 72. 33. 71. 36. 73. 31. 75. 30. 71. 33.          *3
69. 28. 70. 27. 74. 31. 75. 28. 73. 34. 70. 34.                          *4
72. 29. 72. 34. 70. 33. 70. 25. 68. 25. 66. 32. 70. 28. 75. 29.          *1
77. 29. 80. 30. 81. 30. 79. 30. 77. 30. 77. 30. 71. 46. 74. 35.          *2
74. 38. 70. 42. 72. 40. 70. 30. 73. 28. 76. 28. 77. 28. 68. 32.          *3
71. 35. 69. 37. 70. 28. 77. 27. 72. 35. 70. 37. 72. 32.                  *4
73. 30. 76. 33. 78. 39. 75. 42. 72. 42. 69. 40. 70. 39. 71. 35.          *1
76. 35. 76. 36. 72. 37. 73. 43. 78. 37. 76. 40. 74. 37. 73. 43.          *2
69. 41. 72. 43. 73. 38. 67. 35. 60. 40. 67. 43. 67. 43. 65. 34.          *3
72. 28. 67. 31. 72. 29. 72. 29. 71. 34. 75. 30. 75. 28.                  *4
73. 25. 72. 27. 71. 36. 67. 30. 70. 32. 65. 34. 60. 33. 68. 38.          *
70. 36. 71. 32. 71. 33. 63. 32. 60. 46. 60. 33. 56. 22. 65. 20.          *2
65. 22. 61. 24. 65. 22. 67. 23. 70. 23. 67. 24. 59. 34. 49. 38.          *3
57. 25. 58. 24. 57. 30. 62. 35. 61. 25. 57. 22.                          *4
* AUXILLARY RAINGAGE DAILY TOTALS
0        * NSGRD, NUMBER OF STORAGE GAGE RAINFALL DAYS
* HOURLY RAINFALL TOTALS FROM BASE REORDING GAGE
* NO CARDS REQUIRED FOR PERIODS WITH NO RAINFALL
         * IWBG, INDEX NO OF WEATHER BUREAU RAINGAGE
         * YEAR, LAST TWO DIGITS OF CURRENT YEAR
         * MONTH, CURRENT MONTH OF YEAR
         * DATE, CURRENT DAY OF MONTH, 1-31
         * CN,  1 FOR AM    2 FOR PM
* IWBG YR MO DY CN       HOURLY RAINFALL TOTALS IN CHRONOLOGIC ORDER
370 57 10 03 1 .00  .00  .02  .02  .02  .02  .00  .00  .00  .00  .00  .00
370 57 10 04 1 .00  .00  .00  .00  .00  .00  .00  .01  .00  .00  .00  .00
370 57 10 06 2 .00  .00  .00  .00  .00  .02  .03  .02  .00  .00  .00  .00
370 57 10 10 1 .00  .00  .00  .00  .00  .00  .03  .00  .00  .00  .00  .06
370 57 10 12 1 .00  .00  .00  .00  .00  .00  .00  .00  .00  .01  .02  .04
370 57 10 12 2 .05  .02  .02  .00  .01  .00  .00  .03  .00  .00  .02  .00
370 57 10 13 1 .02  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 57 10 13 2 .00  .00  .02  .04  .00  .00  .00  .00  .00  .00  .00  .00
370 57 10 14 2 .00  .00  .00  .00  .00  .03  .00  .00  .00  .00  .00  .00
370 57 10 17 1 .00  .00  .00  .05  .02  .00  .03  .05  .07  .03  .02  .00
370 57 10 19 1 .05  .10  .15  .10  .10  .00  .00  .00  .00  .00  .00  .00
370 57 10 19 2 .00  .00  .00  .01  .00  .05  .05  .05  .05  .00  .00  .00
370 57 10 20 1 .05  .10  .25  .10  .10  .00  .00  .00  .00  .00  .00  .00
370 57 10 20 2 .00  .00  .00  .05  .10  .10  .05  .04  .00  .00  .00  .00
370 57 10 21 1 .05  .05  .05  .05  .05  .00  .00  .00  .00  .00  .00  .00
370 57 10 21 2 .05  .05  .05  .05  .04  .00  .00  .00  .00  .00  .00  .00
370 57 10 22 1 .20  .30  .25  .10  .01  .00  .00  .00  .00  .00  .00  .00
370 57 10 29 1 .00  .00  .00  .00  .03  .00  .00  .00  .00  .00  .00  .00
370 57 11 01 2 .00  .00  .00  .00  .00  .00  .05  .04  .02  .00  .00  .00
370 57 11 02 2 .00  .00  .00  .00  .00  .00  .00  .50  .00  .00  .00  .00
370 57 11 03 1 .00  .05  .10  .10  .15  .06  .04  .00  .00  .00  .00  .00
370 57 11 04 1 .00  .00  .00  .00  .00  .00  .00  .10  .05  .00  .00  .00
370 57 11 05 1 .05  .10  .05  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 57 11 06 1 .00  .00  .00  .00  .00  .00  .00  .08  .12  .00  .00  .00
370 57 11 06 2 .05  .10  .01  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 57 11 15 1 .10  .20  .25  .25  .20  .10  .07  .05  .00  .00  .00  .00
370 57 11 16 1 .00  .00  .00  .00  .00  .00  .00  .05  .10  .10  .10  .10
370 57 11 16 2 .10  .10  .04  .00  .00  .00  .00  .00  .00  .00  .00  .00
```

370	57	11	17	1	.00	.00	.05	.10	.15	.10	.10	.05	.00	.00	.00	.00
370	57	12	15	2	.00	.00	.00	.00	.00	.00	.10	.15	.15	.15	.10	.07
370	57	12	16	1	.05	.04	.04	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	57	12	18	2	.00	.00	.00	.00	.00	.00	.05	.05	.08	.07	.04	.03
370	57	12	19	1	.04	.03	.02	.04	.00	.00	.00	.00	.00	.00	.00	.00
370	57	12	24	1	.00	.00	.03	.06	.00	.00	.00	.00	.00	.00	.00	.00
370	58	01	12	1	.00	.00	.02	.03	.01	.00	.00	.00	.00	.00	.00	.00
370	58	01	13	2	.00	.00	.00	.00	.00	.00	.00	.02	.02	.00	.00	.00
370	58	01	14	1	.00	.05	.05	.10	.02	.00	.00	.00	.00	.00	.00	.00
370	58	01	19	2	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	01	23	1	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00
370	58	01	24	1	.00	.00	.00	.05	.05	.00	.00	.00	.00	.00	.00	.00
370	58	01	25	1	.00	.00	.00	.00	.00	.02	.03	.08	.04	.00	.00	.00
370	58	01	26	2	.00	.00	.00	.00	.00	.00	.00	.08	.00	.00	.00	.00
370	58	01	28	1	.05	.05	.05	.06	.00	.00	.00	.00	.00	.00	.00	.00
370	58	01	29	1	.00	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00
370	58	01	30	2	.03	.04	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	02	04	1	.00	.00	.00	.00	.00	.00	.02	.05	.05	.02	.00	.00
370	58	02	05	1	.05	.10	.10	.10	.10	.10	.05	.00	.00	.00	.00	.00
370	58	02	09	2	.00	.00	.00	.05	.08	.07	.07	.07	.00	.00	.00	.00
370	58	02	13	1	.00	.10	.10	.08	.00	.00	.00	.00	.00	.00	.00	.00
370	58	02	25	2	.10	.10	.10	.10	.10	.10	.10	.10	.03	.00	.00	.00
370	58	02	26	1	.00	.00	.00	.00	.05	.05	.10	.10	.04	.00	.00	.00
370	58	03	05	1	.01	.03	.05	.05	.05	.01	.00	.00	.00	.00	.00	.00
370	58	03	07	1	.02	.02	.05	.10	.08	.00	.00	.00	.00	.00	.00	.00
370	58	03	09	1	.00	.00	.00	.00	.00	.00	.00	.00	.04	.10	.15	.00
370	58	03	09	2	.07	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	03	11	2	.00	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00
370	58	03	14	1	.00	.05	.10	.10	.04	.00	.00	.00	.00	.00	.00	.00
370	58	03	15	2	.00	.00	.00	.00	.00	.00	.00	.05	.05	.05	.05	.01
370	58	03	16	1	.00	.00	.00	.10	.10	.10	.10	.10	.10	.10	.05	.00
370	58	03	18	1	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00
370	58	03	22	2	.07	.10	.10	.10	.10	.00	.00	.00	.00	.00	.00	.00
370	58	03	23	2	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	03	24	2	.00	.00	.06	.06	.00	.00	.00	.00	.00	.00	.00	.00
370	58	03	25	2	.00	.00	.07	.06	.00	.00	.00	.00	.00	.00	.00	.00
370	58	03	26	1	.00	.00	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00
370	58	03	28	1	.00	.00	.00	.00	.00	.00	.00	.10	.15	.15	.15	.15
370	58	03	31	2	.00	.00	.00	.00	.00	.00	.10	.00	.00	.00	.00	.00
370	58	04	02	1	.00	.00	.00	.00	.10	.05	.25	.05	.05	.05	.10	.05
370	58	04	04	1	.05	.10	.10	.10	.10	.10	.10	.10	.10	.10	.05	.00
370	58	04	08	2	.10	.20	.15	.10	.05	.20	.10	.10	.10	.08	.00	.00
370	58	04	09	2	.00	.00	.03	.03	.03	.00	.00	.00	.00	.00	.00	.00
370	58	04	11	2	.00	.00	.00	.00	.00	.05	.08	.07	.06	.04	.02	.00
370	58	04	12	1	.00	.00	.00	.02	.03	.05	.07	.05	.03	.02	.01	.02
370	58	04	29	1	.00	.00	.00	.00	.03	.05	.07	.04	.04	.03	.00	.00
370	58	04	29	2	.02	.10	.15	.08	.07	.00	.00	.00	.00	.00	.00	.00
370	58	04	30	1	.00	.03	.05	.05	.03	.00	.00	.00	.00	.00	.00	.00
370	58	05	11	2	.00	.00	.00	.10	.20	.40	.20	.10	.20	.10	.10	.08
370	58	05	12	1	.08	.07	.05	.03	.02	.00	.00	.00	.00	.00	.00	.00
370	58	05	16	1	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00
370	58	05	18	2	.00	.03	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	05	20	2	.01	.03	.04	.03	.02	.05	.08	.03	.02	.01	.00	.00
370	58	05	21	2	.00	.00	.00	.00	.00	.00	.03	.02	.02	.00	.00	.00
370	58	05	23	2	.00	.00	.03	.02	.00	.00	.00	.00	.00	.00	.00	.00
370	58	06	05	2	.00	.25	.00	.02	.00	.02	.02	.06	.00	.00	.00	.00
370	58	06	06	1	.00	.00	.02	.07	.02	.07	.06	.11	.02	.02	.04	.00
370	58	06	06	2	.11	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
370	58	07	06	2	.00	.00	.00	.00	.09	.00	.00	.00	.00	.00	.00	.00
370	58	07	07	2	.11	.02	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

```
370 58 07 18 2 .04  .06  .00  .06  .00  .00  .01  .03  .00  .00  .00  .00
370 58 07 25 2 .00  .00  .00  .00  .00  .00  .09  .09  .00  .00  .00  .00
370 58 07 30 2 .38  .03  .07  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 08 03 2 .00  .00  .05  .06  .08  .01  .00  .00  .00  .00  .00  .00
370 58 08 04 2 .12  .04  .04  .04  .00  .00  .00  .00  .00  .00  .00  .00
370 58 08 05 2 .00  .00  .00  .00  .20  .15  .10  .10  .10  .00  .00  .00
370 58 08 10 2 .00  .00  .00  .00  .20  .40  .15  .00  .00  .00  .00  .00
370 58 08 12 1 .00  .00  .05  .05  .03  .00  .00  .08  .00  .00  .00  .00
370 58 08 12 2 .00  .00  .00  .06  .00  .00  .00  .00  .00  .00  .00  .00
370 58 08 13 1 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .03  .10
370 58 08 13 2 .00  .00  .00  .00  .00  .07  .00  .00  .00  .00  .00  .00
370 58 08 16 2 .03  .06  .02  .00  .00  .00  .00  .11  .00  .17  .00  .00
370 58 08 19 2 .07  .01  .07  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 08 20 2 .00  .00  .00  .03  .01  .00  .00  .00  .00  .00  .00  .00
370 58 08 21 2 .00  .09  .01  .09  .01  .08  .07  .05  .07  .08  .06  .01
370 58 08 22 1 .07  .04  .03  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 08 23 2 .00  .00  .00  .00  .03  .01  .00  .00  .00  .00  .00  .00
370 58 09 04 2 .03  .03  .03  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 09 05 1 .00  .00  .00  .00  .00  .00  .00  .00  .00  .00  .05  .05
370 58 09 05 2 .05  .05  .05  .05  .04  .00  .00  .00  .00  .00  .00  .00
370 58 09 08 2 .02  .03  .02  .02  .02  .00  .00  .00  .00  .00  .00  .00
370 58 09 10 2 .00  .00  .00  .00  .00  .10  .03  .02  .03  .00  .00  .00
370 58 09 11 2 .00  .00  .00  .00  .00  .00  .06  .04  .04  .00  .00  .00
370 58 09 12 2 .00  .00  .00  .00  .00  .50  .10  .20  .15  .14  .10  .10
370 58 09 14 1 .40  .10  .08  .07  .05  .06  .00  .00  .00  .00  .00  .00
370 58 09 15 2 .00  .05  .03  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 09 16 1 .00  .00  .03  .00  .00  .00  .00  .00  .00  .00  .00  .00
370 58 09 18 2 .00  .05  .04  .03  .02  .00  .00  .00  .00  .00  .00  .00
370 58 09 19 2 .00  .00  .00  .04  .06  .02  .02  .00  .00  .00  .00  .00
370 58 09 23 2 .00  .00  .00  .00  .05  .03  .03  .02  .02  .03  .00  .00
370 58 09 24 1 .02  .01  .08  .02  .01  .06  .03  .05  .02  .02  .02  .00
370 58 09 27 2 .00  .00  .00  .00  .00  .00  .00  .00  .00  .04  .00  .00
370 58 09 28 2 .00  .02  .03  .02  .00  .00  .00  .00  .00  .00  .00  .00
370 98 09 30 1
* 98 IN LAST CARD NOTIFIES PROGRAM THAT IT HAS COME TO THE END OF HOURLY
* RAINFALL TUTALS
* RETURN TO NEW YEAR CARD AND REPEAT DATA TO THIS POINT FOR EACH YEAR
* IN CHRUNOLOGICAL ORDER FOR WHICH FLOWS ARE TO BE SYNTHESIZED
          *STORM DATA - ALAMOSA CREEK NEAR MOOTE VISTA,COLO.
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. STORM 10/18/57
 1.0 107. 121 -1 1
1.0
     16.7      15.2      14.2      13.5      13.0      12.7      12.5      12.3      12.2
     12.1      12.0      11.9      11.8      11.8      11.8      11.8      11.7      11.7
     11.7      11.7      11.6      11.6      11.6      11.6      11.5      11.5      11.5
     11.5      11.4      11.4      11.4      11.4      10.9      10.8      10.8      10.8
     10.8      10.8      10.7      10.7      10.7      10.7      10.8      11.5      14.5
     19.1      25.0      30.3      33.5      32.3      26.9      22.1      18.9      16.7
     15.2      14.1      13.4      12.9      12.6      12.3      12.2      12.1      12.1
     12.1      12.6      14.7      19.7      28.8      39.0      49.6      55.8      53.4
     46.6      38.1      31.3      26.7      23.5      21.3      19.8      18.7      17.5
     17.0      16.7      16.4      16.3      16.2      16.7      18.1      21.6      26.8
     33.0      38.5      41.7      39.6      34.4      29.8      26.6      24.4      22.8
     21.8      21.1      20.6      20.3      20.1      19.9      19.8      19.7      19.7
     19.7      19.6      19.6      19.6      19.6      19.6      19.6      19.6      19.6
     19.6      19.6      19.6
```

```
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. STORM 4/21/58
 1.0 107. 121 -1 1
 1.0
     19.1    19.1    19.1    19.0    19.0    18.9    18.9    18.9    17.7
     17.7    17.6    17.6    17.5    17.5    17.5    17.4    17.4    17.3
     17.3    17.3    18.3    18.3    18.3    18.2    18.2    18.2    18.1
     18.1    18.0    18.0    18.0    17.9    16.7    16.7    16.7    16.6
     16.6    16.6    16.5    16.9    17.9    20.0    23.6    28.1    34.2
     38.2    39.8    38.8    36.3    33.1    29.9    27.5    25.8    24.6
     23.8    23.2    21.6    21.3    21.1    20.9    20.8    20.7    20.6
     20.5    21.1    22.5    24.6    27.3    31.2    34.1    35.7    35.2
     33.3    30.9    29.1    27.8    26.9    26.2    25.8    25.4    24.0
     23.8    23.7    23.5    23.4    23.4    23.3    23.2    23.2    23.1
     23.0    22.9    24.0    23.9    23.9    23.8    23.8    23.7    23.7
     23.6    23.6    23.5    23.5    23.4    23.4    23.3    23.3    23.2
     23.2    23.2    23.1    23.1    23.1    23.1    23.0    23.0    23.0
     22.9    22.9    22.9
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. STORM 5/10/58
 1.0 107. 121 -1 1
 1.0
    207.4   203.8   200.1   197.2   194.9   193.1   191.6   190.3   187.9
    186.9   186.0   185.2   184.4   183.7   185.5   189.4   194.9   202.4
    211.5   221.7   231.4   235.7   236.4   234.2   229.9   224.6   219.2
    214.7   211.3   208.8   206.7   205.1   202.1   200.9   199.9   198.9
    198.1   197.3   199.8   211.8   232.9   271.3   331.9   426.0   556.7
    694.4   831.9   929.5   984.9  1024.8  1041.5  1041.0  1029.3  1010.3
    991.0   972.9   954.4   938.3   923.1   908.4   894.8   884.3   875.0
    867.7   861.9   857.3   853.5   848.0   841.7   831.5   819.6   806.4
    792.4   778.4   765.1   752.9   741.5   730.8   720.6   710.8   699.7
    690.5   681.6   672.9   664.4   656.2   648.1   640.2   633.1   628.3
    624.0   620.7   619.5   616.5   613.2   607.5   599.8   591.0   582.0
    573.7   566.1   559.0   552.4   546.1   538.4   532.6   526.9   521.4
    516.1   510.9   507.4   506.5   506.7   508.5   511.7   515.7   520.2
    519.6   516.1   510.0
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. STORM 8/3/58
 1.0 107. 121 -1 1
 1.0
     20.8    20.8    20.7    20.7    20.6    20.6    20.6    20.5    16.4
     16.3    16.3    16.3    16.2    16.2    16.1    16.3    17.8    22.6
     29.7    36.2    45.5    45.8    39.9    33.8    29.4    26.3    24.2
     22.8    21.8    21.1    20.6    20.2    15.9    15.7    15.5    15.4
     15.5    16.9    21.8    28.1    35.6    43.6    44.8    42.4    41.8
     35.3    30.1    26.6    24.2    22.5    21.3    20.5    19.9    19.5
     19.2    19.0    14.8    14.7    14.6    14.4    14.4    14.3    14.3
     14.2    14.5    17.8    29.4    46.6    71.5    95.1   107.8   106.2
     97.3    83.3    64.7    50.1    40.1    33.2    28.5    25.2    18.9
     17.3    16.3    15.5    15.0    14.6    14.3    14.1    14.0    13.9
     13.8    13.6    17.7    17.6    17.6    17.6    17.5    17.5    17.5
     17.4    17.4    17.3    17.3    17.3    13.2    13.1    13.1    13.0
     13.0    13.0    12.9    12.9    12.9    12.8    12.8    12.8    16.8
     16.8    16.7    16.7
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. STORM 9/22/58
 1.0 107. 121 -1 1
 1.0
     18.4    18.4    18.3    18.3    18.3    18.2    18.2    18.2    15.0
     15.0    14.9    14.8    14.7    14.7    14.7    14.6    14.6    14.5
     14.5    14.5    17.5    17.5    17.5    17.4    17.4    17.4    17.3
     17.3    17.2    17.2    17.2    17.1    14.0    14.0    13.9    13.9
     13.8    13.8    13.8    13.7    13.8    14.0    15.2    17.7    24.3
     28.4    32.3    34.7    34.6    33.5    32.7    31.5    33.6    37.4
     41.7    48.0    48.1    49.8    52.3    51.8    49.8    45.2    40.3
     35.5    30.7    27.1    24.6    22.8    23.2    22.4    21.8    21.4
     21.1    20.9    20.8    20.7    20.6    20.5    20.4    20.4    17.2
     17.2    17.2    17.2    17.1    17.1    17.1    17.1    17.0    17.0
     16.9    16.9    20.0    19.9    19.9    19.9    19.8    19.8    19.7
     19.7    19.7    19.6    19.6    19.6    16.4    16.4    16.3    16.3
     16.3    16.2    16.2    16.1    16.1    16.1    16.0    16.0    19.0
     19.0    19.0    18.9
```

OCTOBER

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62

3	AM	25.0	24.9	24.9	24.8	24.8	24.7	24.7	24.6	23.2	23.1	23.1	23.0	
	PM	23.5	24.8	25.9	26.9	27.8	26.6	25.3	24.4	25.2	24.8	24.4	24.2	24.8
	MAXIMUM=	28.2	C.F.S.	TIME	4.45	P.M.								
4	AM	24.0	23.9	23.8	23.6	23.5	23.5	23.4	23.4	21.9	21.9	21.8	21.8	
	PM	21.7	21.7	21.6	21.6	21.5	21.5	21.4	21.4	22.7	22.7	22.6	22.6	22.5
	MAXIMUM=	24.1	C.F.S.	TIME	0.15	A.M.								
6	AM	21.4	21.4	21.3	21.3	21.2	21.2	21.1	21.1	18.2	18.2	18.2	18.1	
	PM	18.1	18.0	18.0	17.9	17.9	17.8	17.8	17.8	21.2	22.4	23.4	24.2	19.9
	MAXIMUM=	24.6	C.F.S.	TIME	12.00	P.M.								
7	AM	24.7	23.6	22.5	21.7	21.2	20.8	20.6	20.4	17.4	17.3	17.2	17.1	
	PM	17.0	17.0	16.9	16.9	16.9	16.8	16.8	16.7	19.5	19.4	19.4	19.4	19.1
	MAXIMUM=	24.9	C.F.S.	TIME	0.45	A.M.								
10	AM	17.4	17.4	17.3	17.3	17.3	17.2	17.2	17.2	15.7	15.7	15.7	15.7	
	PM	16.4	18.6	20.4	22.2	23.6	21.7	19.7	18.3	18.7	18.1	17.6	17.3	18.1
	MAXIMUM=	24.1	C.F.S.	TIME	4.45	P.M.								
11	AM	17.0	16.8	16.7	16.6	16.5	16.4	16.3	16.3	15.3	15.3	15.2	15.2	
	PM	15.2	15.2	15.1	15.1	15.1	15.0	15.0	15.0	15.9	15.8	15.8	15.9	15.7
	MAXIMUM=	17.1	C.F.S.	TIME	0.15	A.M.								
12	AM	15.7	15.7	15.7	15.6	15.6	15.6	15.5	15.5	14.5	14.5	14.5	14.5	
	PM	15.1	17.6	22.0	26.9	32.0	34.4	32.9	29.8	27.4	25.9	24.5	23.7	20.6
	MAXIMUM=	35.0	C.F.S.	TIME	5.45	P.M.								
12	SDEPTH=	0.14	STMD=	0.13	SAX=	15.00	TANSM=	0.00	SPLW=	0.0				
13	AM	23.3	21.2	19.2	17.8	16.9	16.2	15.8	15.4	15.2	15.0	14.9	14.8	
	PM	14.7	14.6	14.6	14.8	16.2	19.0	21.4	23.6	24.5	22.0	19.6	17.9	17.9
	MAXIMUM=	24.9	C.F.S.	TIME	8.45	P.M.								
13	SDEPTH=	0.23	STMD=	0.10	SAX=	15.00	TANSM=	0.00	SPLW=	0.00				
14	AM	16.8	16.0	15.4	15.0	14.7	14.5	14.4	14.3	14.2	14.1	14.0	14.0	
	PM	13.9	13.9	13.9	13.8	13.8	13.8	14.2	15.2	16.0	16.8	17.5	16.6	14.9
	MAXIMUM=	17.8	C.F.S.	TIME	10.45	P.M.								
14	SDEPTH=	0.12	STMD=	0.03	SAX=	15.00	TANSM=	0.00	SPLW=	0.00				
15	AM	15.6	15.0	14.5	14.2	13.9	13.8	12.6	13.5	12.5	12.4	12.4	12.4	
	PM	12.3	12.3	12.3	12.2	12.2	12.2	12.2	12.1	13.0	13.0	13.0	12.9	13.1
	MAXIMUM=	16.0	C.F.S.	TIME	0.15	A.M.								

B-10

17	AM	12.3	12.2	12.2	12.2	12.2	12.1	12.1	12.1	11.7	12.1	13.9	17.6	
	PM	22.6	28.7	33.7	36.2	36.7	35.6	34.1	31.9	29.4	25.8	21.8	18.8	21.2

MAXIMUM= 36.8 C.F.S. TIME 4.45 P.M.

18	AM	16.7	15.2	14.2	13.5	13.0	12.7	12.5	12.3	12.2	12.1	12.0	11.9	
	PM	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.7	11.6	11.6	11.6	11.6	12.4

MAXIMUM= 17.4 C.F.S. TIME 0.15 A.M.

19	AM	11.5	11.5	11.5	11.5	11.4	11.4	11.4	11.4	10.9	10.8	10.8	10.8	
	PM	10.8	10.8	10.7	10.7	10.7	10.7	10.8	11.5	14.5	19.1	25.0	30.2	12.9

MAXIMUM= 31.8 C.F.S. TIME 12.00 P.M.

19 SDEPTH= 2.77 STMD= 0.18 SAX= 15.00 TANSM= 0.04 SPLW= 0.02

20	AM	33.5	32.3	26.8	22.1	18.8	16.6	15.0	14.0	13.3	12.8	12.4	12.2	
	PM	12.0	12.0	11.9	11.9	12.4	14.5	19.5	28.6	38.8	49.6	56.0	53.8	22.9

MAXIMUM= 57.3 C.F.S. TIME 10.45 P.M.

20 SDEPTH= 6.16 STMD= 0.19 SAX= 15.00 TANSM= 0.06 SPLW= 0.04

21	AM	47.1	38.7	32.0	27.3	24.1	21.9	20.4	19.3	18.0	17.5	17.1	16.8	
	PM	16.7	16.5	17.0	18.4	21.9	27.1	33.3	38.9	42.1	40.1	34.9	30.3	26.5

MAXIMUM= 49.7 C.F.S. TIME 0.15 A.M.

21 SDEPTH= 7.77 STMD= 0.19 SAX= 15.00 TANSM= 0.04 SPLW= 0.06

22	AM	27.1	24.9	23.3	22.3	21.5	21.0	20.6	20.4	20.2	20.0	19.9	19.8	
	PM	19.8	19.7	19.7	19.6	19.6	19.6	19.5	19.5	19.5	19.4	19.4	19.4	20.7

MAXIMUM= 28.1 C.F.S. TIME 0.15 A.M.

22 SDEPTH= 12.74 STMD= 0.18 SAX= 12.00 TANSM= 0.18 SPLW= 0.06

23	AM	19.4	19.3	19.3	19.3	19.2	19.2	19.2	19.1	17.9	17.9	17.9	17.8	
	PM	17.8	17.8	17.8	17.7	17.7	17.7	17.6	17.6	18.7	18.7	18.7	18.6	18.4

MAXIMUM= 19.4 C.F.S. TIME 0.15 A.M.

23 SDEPTH= 12.71 STMD= 0.18 SAX= 13.00 TANSM= 0.17 SPLW= 0.06

24	AM	18.6	18.6	18.5	18.5	18.4	18.4	18.4	18.3	17.1	17.1	17.1	17.0	
	PM	17.0	17.0	16.9	16.9	16.9	16.8	16.8	16.8	17.9	17.9	17.8	17.8	17.6

MAXIMUM= 18.6 C.F.S. TIME 0.15 A.M.

24 SDEPTH= 12.67 STMD= 0.18 SAX= 14.00 TANSM= 0.17 SPLW= 0.06

25	AM	17.8	17.7	17.7	17.6	17.6	17.6	17.5	17.5	16.3	16.3	16.2	16.2	
	PM	16.2	16.1	16.1	16.1	16.0	16.0	16.0	15.9	17.1	17.0	17.0	17.0	16.8

MAXIMUM= 17.8 C.F.S. TIME 0.15 A.M.

25 SDEPTH= 12.63 STMD= 0.17 SAX= 15.00 TANSM= 0.17 SPLW= 0.06

26	AM	16.9	16.9	16.9	16.8	16.8	16.8	16.7	16.7	15.5	15.4	15.4	15.4	
	PM	15.3	15.3	15.3	15.3	15.2	15.2	15.2	15.1	16.3	16.2	16.2	16.2	16.0

MAXIMUM= 17.0 C.F.S. TIME 0.15 A.M.

26 SDEPTH= 12.60 STMD= 0.17 SAX= 15.00 TANSM= 0.17 SPLW= 0.06

```
 27 AM   16.1   16.1   16.1   16.0   16.0   16.0    15.9   15.9   15.9   15.8   15.8   15.8
    PM   15.7   15.7   15.7   15.6   15.6   15.5    15.5   15.4   15.3   15.3   15.3   15.3   15.7
          MAXIMUM=   16.2  C.F.S.    TIME    0.15  A.M.
  27  SDEPTH=  12.41  STMD=  0.17  SAX= 15.00  TANSM=  0.17  SPLW=  0.06

 28 AM   15.2   15.2   15.2   15.2   15.1   15.1    15.1   15.1   13.9   13.8   13.8   13.8
    PM   13.8   13.7   13.7   13.7   13.7   13.6    13.6   13.6   14.7   14.7   14.7   14.6   14.4
          MAXIMUM=   13.8  C.F.S.    TIME   11.15  A.M.
  28  SDEPTH=  11.43  STMD=  0.19  SAX= 15.00  TANSM=  0.02  SPLW=  0.06

 29 AM   14.6   14.6   14.6   14.5   14.5   14.5    14.4   14.4   14.4   14.4   14.3   14.3
    PM   14.3   14.3   14.2   14.2   14.2   14.2    14.1   14.1   14.1   14.1   14.0   14.0   14.3
          MAXIMUM=   14.3  C.F.S.    TIME   11.15  A.M.
  29  SDEPTH=  11.03  STMD=  0.20  SAX= 15.00  TANSM=  0.12  SPLW=  0.06

 30 AM   14.0   14.0   13.9   13.9   13.9   13.9    13.8   13.8   12.6   12.6   12.6   12.5
    PM   12.5   12.5   12.5   12.5   12.4   12.4    12.5   12.9   15.1   16.7   18.5   20.2   13.8
          MAXIMUM=   20.7  C.F.S.    TIME   12.00  P.M.
  30  SDEPTH=   9.66  STMD=  0.21  SAX= 15.00  TANSM=  0.03  SPLW=  0.08

 31 AM   21.0   20.2   18.7   17.3   16.3   15.6    15.1   14.8   13.2   13.0   12.9   12.8
    PM   12.8   12.7   12.7   12.7   12.7   12.8    13.1   14.2   17.5   19.9   22.6   24.5   15.8
          MAXIMUM=   24.8  C.F.S.    TIME   12.00  P.M.
  31  SDEPTH=   8.51  STMD=  0.23  SAX= 15.00  TANSM=  0.0   SPLW=  0.08
NOVEMBER

  1 AM   24.8   23.8   22.1   20.2   18.6   17.4    16.6   16.0   15.6   15.3   15.1   15.0
    PM   14.9   14.9   14.8   14.7   14.7   14.7    15.4   17.0   19.9   23.9   27.6   31.0   18.5
          MAXIMUM=   31.6  C.F.S.    TIME   11.45  P.M.
   1  SDEPTH=   8.04  STMD=  0.24  SAX= 15.00  TANSM=  0.06  SPLW=  0.07

  2 AM   31.2   27.9   24.7   22.4   20.9   19.8    19.1   18.6   18.2   18.0   17.8   17.7
    PM   17.6   17.6   17.5   17.5   17.5   17.4    17.4   17.4   17.4   17.4   17.4   17.4   19.4
          MAXIMUM=   31.5  C.F.S.    TIME    0.15  A.M.
   2  SDEPTH=   9.60  STMD=  0.25  SAX= 15.00  TANSM=  0.19  SPLW=  0.07

  3 AM   17.4   17.4   17.4   17.3   17.3   17.3    17.3   17.3   17.3   17.3   17.3   17.2
    PM   17.2   17.2   17.2   17.2   17.2   17.2    17.2   17.2   17.2   17.2   17.2   17.2   17.3
          MAXIMUM=   17.4  C.F.S.    TIME    0.15  A.M.
   3  SDEPTH=  11.81  STMD=  0.24  SAX= 13.00  TANSM=  0.22  SPLW=  0.07

  4 AM   17.1   17.1   17.1   17.1   17.1   17.1    17.1   17.1   17.0   17.0   17.0   17.0
    PM   17.0   17.0   17.0   17.0   17.0   17.0    16.9   16.9   16.9   16.9   16.9   16.9   17.0
          MAXIMUM=   17.1  C.F.S.    TIME    0.15  A.M.
   4  SDEPTH=  11.98  STMD=  0.25  SAX= 13.00  TANSM=  0.21  SPLW=  0.07
```

```
 5 AM   16.9  16.9  16.9  16.8  16.8  16.8    16.8  16.8  16.8  16.8  16.8  16.7
   PM   16.7  16.7  16.7  16.7  16.7  16.7    16.7  16.7  16.7  16.6  16.6  16.6  16.7
        MAXIMUM=   16.9  C.F.S.   TIME   0.15  A.M.
  5  SDEPTH=  14.17  STMD=  0.22  SAX= 13.00  TANSM=  0.24  SPLW=  0.07

 6 AM   16.6  16.5  16.4  16.4  16.4  16.4    16.4  16.4  16.4  16.4  16.4  16.4
   PM   16.3  16.3  16.3  16.3  16.3  16.3    16.3  16.3  16.3  16.3  16.3  16.3  16.4
        MAXIMUM=   16.6  C.F.S.   TIME   0.15  A.M.
  6  SDEPTH=  16.29  STMD=  0.21  SAX= 12.00  TANSM=  0.27  SPLW=  0.07

 7 AM   16.3  16.3  16.2  16.2  16.2  16.2    16.2  16.2  16.2  16.2  16.1  16.1
   PM   16.1  16.1  16.1  16.1  16.1  16.1    16.1  16.1  16.1  16.1  16.1  16.0  16.1
        MAXIMUM=   16.1  C.F.S.   TIME  11.15  A.M.
  7  SDEPTH=  16.19  STMD=  0.21  SAX= 13.00  TANSM=  0.27  SPLW=  0.07

 8 AM   16.0  16.0  16.0  16.0  16.0  16.0    16.0  16.0  15.9  15.9  15.9  15.9
   PM   15.9  15.9  15.9  15.9  15.9  15.9    15.9  15.8  15.8  15.8  15.8  15.8  15.9
        MAXIMUM=   15.9  C.F.S.   TIME  11.15  A.M.
  8  SDEPTH=  16.02  STMD=  0.21  SAX= 14.00  TANSM=  0.26  SPLW=  0.07

 9 AM   15.8  15.8  15.8  15.8  15.8  15.7    15.7  15.7  15.7  15.7  15.7  15.7
   PM   15.7  15.7  15.6  15.6  15.6  15.6    15.6  15.6  15.6  15.6  15.6  15.6  15.7
        MAXIMUM=   15.7  C.F.S.   TIME  11.15  A.M.
  9  SDEPTH=  15.84  STMD=  0.21  SAX= 15.00  TANSM=  0.26  SPLW=  0.07

10 AM   15.6  15.6  15.5  15.5  15.5  15.5    15.5  15.5  15.5  15.5  15.4  15.4
   PM   15.4  15.4  15.4  15.4  15.4  15.4    15.4  15.4  15.4  15.4  15.3  15.3  15.4
        MAXIMUM=   15.4  C.F.S.   TIME  11.15  A.M.
 10  SDEPTH=  15.75  STMD=  0.21  SAX= 15.00  TANSM=  0.26  SPLW=  0.07

11 AM   15.3  15.3  15.3  15.3  15.3  15.3    15.3  15.3  15.2  15.2  15.2  15.2
   PM   15.2  15.2  15.2  15.2  15.2  15.2    15.2  15.1  15.1  15.1  15.1  15.1  15.2
        MAXIMUM=   15.2  C.F.S.   TIME  11.15  A.M.
 11  SDEPTH=  15.58  STMD=  0.21  SAX= 15.00  TANSM=  0.26  SPLW=  0.07

12 AM   15.1  15.1  15.1  15.1  15.1  15.1    15.0  15.0  15.0  15.0  15.0  15.0
   PM   15.0  15.0  15.0  15.0  15.0  14.9    14.9  14.9  14.9  14.9  14.9  14.9  15.0
        MAXIMUM=   15.0  C.F.S.   TIME  11.15  A.M.
 12  SDEPTH=  15.42  STMD=  0.21  SAX= 15.00  TANSM=  0.26  SPLW=  0.07

13 AM   14.9  14.9  14.9  14.9  14.8  14.8    14.8  14.8  14.8  14.8  14.8  14.8
   PM   14.8  14.8  14.8  14.7  14.7  14.7    14.7  14.7  14.7  14.7  14.7  14.7  14.8
        MAXIMUM=   14.8  C.F.S.   TIME  11.15  A.M.
 13  SDEPTH=  15.25  STMD=  0.21  SAX= 15.00  TANSM=  0.25  SPLW=  0.07

14 AM   14.7  14.7  14.7  14.7  14.6  14.6    14.6  14.6  14.6  14.6  14.6  14.6
   PM   14.6  14.6  14.6  14.5  14.5  14.5    14.5  14.5  14.5  14.5  14.5  14.5  14.6
        MAXIMUM=   14.6  C.F.S.   TIME  11.15  A.M.
 14  SDEPTH=  15.08  STMD=  0.21  SAX= 15.00  TANSM=  0.25  SPLW=  0.07
```

15	AM	14.5	14.5	14.5	14.5	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	
	PM	14.4	14.4	14.4	14.4	14.4	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.4

MAXIMUM= 14.4 C.F.S. TIME 11.15 A.M.

15 SDEPTH= 30.40 STMD= 0.14 SAX= 11.00 TANSM= 0.34 SPLW= 0.07

16	AM	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.2	14.2	14.2	14.2	14.2	
	PM	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.1	14.1	14.2

MAXIMUM= 14.2 C.F.S. TIME 11.15 A.M.

16 SDEPTH= 31.02 STMD= 0.16 SAX= 8.00 TANSM= 0.39 SPLW= 0.07

17	AM	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.0	14.0	
	PM	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0

MAXIMUM= 14.0 C.F.S. TIME 11.15 A.M.

17 SDEPTH= 39.01 STMD= 0.14 SAX= 7.00 TANSM= 0.43 SPLW= 0.07

18	AM	14.0	14.0	14.0	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	
	PM	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.8	13.8	13.8	13.8	13.9

MAXIMUM= 13.9 C.F.S. TIME 11.15 A.M.

18 SDEPTH= 38.89 STMD= 0.14 SAX= 8.00 TANSM= 0.43 SPLW= 0.07

19	AM	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.7	13.7	
	PM	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7

MAXIMUM= 13.7 C.F.S. TIME 11.15 A.M.

19 SDEPTH= 38.77 STMD= 0.14 SAX= 9.00 TANSM= 0.42 SPLW= 0.07

20	AM	13.7	13.7	13.7	13.7	13.7	13.7	13.6	13.6	13.6	13.6	13.6	13.6	
	PM	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6

MAXIMUM= 13.6 C.F.S. TIME 11.15 A.M.

20 SDEPTH= 38.64 STMD= 0.14 SAX= 10.00 TANSM= 0.42 SPLW= 0.07

21	AM	13.6	13.6	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	
	PM	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.4	13.5

MAXIMUM= 13.5 C.F.S. TIME 11.15 A.M.

21 SDEPTH= 38.51 STMD= 0.14 SAX= 11.00 TANSM= 0.42 SPLW= 0.07

22	AM	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	
	PM	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.3	13.3	13.3	13.4

MAXIMUM= 13.4 C.F.S. TIME 11.15 A.M.

22 SDEPTH= 38.39 STMD= 0.14 SAX= 12.00 TANSM= 0.42 SPLW= 0.07

23	AM	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	
	PM	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.2	13.2	13.2	13.3

MAXIMUM= 13.3 C.F.S. TIME 11.15 A.M.

23 SDEPTH= 38.26 STMD= 0.14 SAX= 13.00 TANSM= 0.41 SPLW= 0.07

24	AM	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	
	PM	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2

MAXIMUM= 13.2 C.F.S. TIME 11.15 A.M.

24 SDEPTH= 38.13 STMD= 0.14 SAX= 14.00 TANSM= 0.41 SPLW= 0.07

25	AM	13.2	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	
	PM	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1

MAXIMUM= 13.1 C.F.S. TIME 11.15 A.M.

25 SDEPTH= 37.99 STMD= 0.14 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

26	AM	13.1	13.1	13.1	13.1	13.1	13.0	13.0	13.0	13.0	13.0	13.0	13.0	
	PM	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0

MAXIMUM= 13.0 C.F.S. TIME 11.15 A.M.

26 SDEPTH= 37.77 STMD= 0.14 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

27	AM	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.9	
	PM	12.9	13.0	13.0	13.0	13.0	13.0	12.9	12.9	12.9	12.9	12.9	12.9	13.0

MAXIMUM= 13.0 C.F.S. TIME 11.15 A.M.

27 SDEPTH= 37.64 STMD= 0.14 SAX= 15.00 TANSM= 0.40 SPLW= 0.07

28	AM	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	
	PM	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9

MAXIMUM= 12.9 C.F.S. TIME 11.15 A.M.

28 SDEPTH= 37.51 STMD= 0.14 SAX= 15.00 TANSM= 0.40 SPLW= 0.07

29	AM	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.8	12.8	12.8	
	PM	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.9

MAXIMUM= 12.8 C.F.S. TIME 11.15 A.M.

29 SDEPTH= 37.38 STMD= 0.14 SAX= 15.00 TANSM= 0.40 SPLW= 0.07

30	AM	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	
	PM	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8	12.8

MAXIMUM= 12.8 C.F.S. TIME 11.15 A.M.

30 SDEPTH= 37.26 STMD= 0.14 SAX= 15.00 TANSM= 0.40 SPLW= 0.07

DECEMBER

1	AM	12.8	13.5	14.1	14.6	15.0	15.4	15.7	16.0	16.3	16.5	16.7	16.9	
	PM	17.1	17.4	17.5	17.7	17.9	18.0	18.1	18.2	18.4	18.5	18.5	18.6	16.7

MAXIMUM= 16.7 C.F.S. TIME 11.15 A.M.

1 SDEPTH= 37.14 STMD= 0.14 SAX= 15.00 TANSM= 0.40 SPLW= 0.07

2	AM	18.7	18.8	18.9	18.9	19.0	19.0	19.1	19.1	19.2	19.2	19.2	19.3	
	PM	19.3	19.4	19.4	19.5	19.5	19.6	19.6	19.6	19.7	19.7	19.7	19.7	19.3

MAXIMUM= 19.2 C.F.S. TIME 11.15 A.M.

2 SDEPTH= 37.02 STMD= 0.13 SAX= 15.00 TANSM= 0.39 SPLW= 0.07

3	AM	19.7	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.9	19.9	19.9	
	PM	19.9	19.9	19.9	19.9	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.9

MAXIMUM= 19.9 C.F.S. TIME 11.15 A.M.

3 SDEPTH= 36.90 STMD= 0.13 SAX= 15.00 TANSM= 0.39 SPLW= 0.07

```
 4  AM    20.0   20.0   20.0   20.0   20.0   20.0     20.0   20.0   20.0   20.0   20.0   20.0
    PM    20.0   20.0   20.0   20.0   20.0   20.0     20.0   20.0   20.0   20.0   20.0   20.0   20.0
       MAXIMUM=    20.0  C.F.S.    TIME   11.15  A.M.
  4  SDEPTH=   36.78  STMD=  0.13  SAX= 15.00  TANSM=  0.39  SPLW=  0.07

 5  AM    20.0   20.0   20.0   20.0   20.0   20.0     20.0   20.0   19.9   19.9   19.9   19.9
    PM    19.9   19.9   19.9   19.9   19.9   19.9     19.9   19.9   19.9   19.9   19.9   19.9   19.9
       MAXIMUM=    19.9  C.F.S.    TIME   11.15  A.M.
  5  SDEPTH=   36.65  STMD=  0.13  SAX= 15.00  TANSM=  0.39  SPLW=  0.07

 6  AM    19.9   19.9   19.9   19.8   19.8   19.8     19.8   19.8   19.8   19.8   19.8   19.7
    PM    19.8   19.8   19.7   19.7   19.7   19.7     19.7   19.7   19.7   19.7   19.7   19.7   19.8
       MAXIMUM=    19.8  C.F.S.    TIME   11.15  A.M.
  6  SDEPTH=   36.32  STMD=  0.13  SAX= 15.00  TANSM=  0.38  SPLW=  0.07

 7  AM    19.7   19.7   19.7   19.7   19.6   19.6     19.6   19.6   19.6   19.6   19.6   19.6
    PM    19.5   19.5   19.5   19.5   19.5   19.5     19.5   19.5   19.5   19.5   19.5   19.5   19.6
       MAXIMUM=    19.6  C.F.S.    TIME   11.15  A.M.
  7  SDEPTH=   36.19  STMD=  0.13  SAX= 15.00  TANSM=  0.38  SPLW=  0.07

 8  AM    19.5   19.5   19.5   19.4   19.4   19.4     19.4   19.4   19.4   19.4   19.4   19.3
    PM    19.3   19.3   19.3   19.3   19.3   19.3     19.3   19.3   19.3   19.3   19.3   19.3   19.4
       MAXIMUM=    19.4  C.F.S.    TIME   11.15  A.M.
  8  SDEPTH=   36.07  STMD=  0.13  SAX= 15.00  TANSM=  0.38  SPLW=  0.07

 9  AM    19.3   19.3   19.2   19.2   19.2   19.2     19.2   19.2   19.2   19.1   19.1   19.1
    PM    19.1   19.1   19.1   19.1   19.1   19.1     19.1   19.1   19.1   19.1   19.1   19.1   19.1
       MAXIMUM=    19.1  C.F.S.    TIME   11.15  A.M.
  9  SDEPTH=   35.67  STMD=  0.13  SAX= 15.00  TANSM=  0.37  SPLW=  0.07

10  AM    19.0   19.0   19.0   19.0   19.0   19.0     19.0   19.0   18.9   18.9   18.9   18.9
    PM    18.9   18.9   18.9   18.9   18.9   18.9     18.9   18.9   18.9   18.9   18.9   18.8   18.9
       MAXIMUM=    18.9  C.F.S.    TIME   11.15  A.M.
 10  SDEPTH=   35.36  STMD=  0.13  SAX= 15.00  TANSM=  0.37  SPLW=  0.07

11  AM    18.8   18.8   18.8   18.8   18.8   18.8     18.8   18.8   18.7   18.7   18.7   18.7
    PM    18.7   18.7   18.7   18.7   18.7   18.7     18.7   18.7   18.7   18.7   18.7   18.6   18.7
       MAXIMUM=    18.7  C.F.S.    TIME   11.15  A.M.
 11  SDEPTH=   35.23  STMD=  0.13  SAX= 15.00  TANSM=  0.37  SPLW=  0.07

12  AM    18.6   18.6   18.6   18.6   18.6   18.6     18.6   18.6   18.5   18.5   18.5   18.5
    PM    18.5   18.5   18.5   18.5   18.5   18.5     18.5   18.5   18.5   18.5   18.5   18.5   18.5
       MAXIMUM=    18.5  C.F.S.    TIME   11.15  A.M.
 12  SDEPTH=   35.12  STMD=  0.13  SAX= 15.00  TANSM=  0.37  SPLW=  0.07
```

13 AM 18.5 18.4 18.4 18.4 18.4 18.4 18.4 18.4 18.4 18.4 18.3 18.3
PM 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.3 18.4
MAXIMUM= 18.3 C.F.S. TIME 11.15 A.M.
13 SDEPTH= 35.01 STMD= 0.13 SAX= 15.00 TANSM= 0.37 SPLW= 0.07

14 AM 18.3 18.3 18.3 18.3 18.2 18.2 18.2 18.2 18.2 18.2 18.2 18.2
PM 18.2 18.2 18.2 18.2 18.2 18.2 18.2 18.1 18.1 18.1 18.1 18.1 18.2
MAXIMUM= 18.2 C.F.S. TIME 11.15 A.M.
14 SDEPTH= 34.89 STMD= 0.13 SAX= 15.00 TANSM= 0.37 SPLW= 0.07

15 AM 18.1 18.1 18.1 18.1 18.1 18.1 18.1 18.0 18.0 18.0 18.0 18.0
PM 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0 18.0
MAXIMUM= 18.0 C.F.S. TIME 11.15 A.M.
15 SDEPTH= 37.58 STMD= 0.14 SAX= 12.00 TANSM= 0.39 SPLW= 0.07

16 AM 18.0 18.0 18.0 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9
PM 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.9 17.8 17.8 17.8 17.9
MAXIMUM= 17.9 C.F.S. TIME 11.15 A.M.
16 SDEPTH= 39.18 STMD= 0.14 SAX= 13.00 TANSM= 0.42 SPLW= 0.07

17 AM 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.7 17.7 17.7
PM 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.8
MAXIMUM= 17.7 C.F.S. TIME 11.15 A.M.
17 SDEPTH= 38.90 STMD= 0.14 SAX= 14.00 TANSM= 0.42 SPLW= 0.07

18 AM 17.7 17.7 17.7 17.7 17.7 17.7 17.7 17.6 17.6 17.6 17.6 17.6
PM 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6 17.6
MAXIMUM= 17.6 C.F.S. TIME 11.15 A.M.
18 SDEPTH= 39.15 STMD= 0.14 SAX= 15.00 TANSM= 0.35 SPLW= 0.07

19 AM 17.6 17.6 17.6 17.6 17.6 17.6 17.5 17.5 17.5 17.5 17.5 17.5
PM 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5 17.5
MAXIMUM= 17.5 C.F.S. TIME 11.15 A.M.
19 SDEPTH= 40.81 STMD= 0.14 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

20 AM 17.5 17.5 17.5 17.5 17.5 17.5 17.4 17.4 17.4 17.4 17.4 17.4
PM 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.4
MAXIMUM= 17.4 C.F.S. TIME 11.15 A.M.
20 SDEPTH= 40.71 STMD= 0.14 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

21 AM 17.4 17.4 17.4 17.4 17.4 17.4 17.4 17.3 17.3 17.3 17.3 17.3
PM 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3
MAXIMUM= 17.3 C.F.S. TIME 11.15 A.M.
21 SDEPTH= 40.60 STMD= 0.14 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

22 AM 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.3 17.2 17.2 17.2
PM 17.2 17.2 17.2 17.2 17.2 17.2 17.3 17.2 17.2 17.2 17.2 17.2 17.3
MAXIMUM= 17.2 C.F.S. TIME 11.15 A.M.
22 SDEPTH= 40.50 STMD= 0.14 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

```
23  AM     17.2    17.2    17.2    17.2    17.2    17.2      17.2    17.2    17.2    17.2    17.2    17.2
    PM     17.2    17.2    17.2    17.2    17.2    17.2      17.2    17.2    17.2    17.2    17.2    17.2     17.2
       MAXIMUM=    17.2  C.F.S.     TIME    11.15  A.M.
  23  SDEPTH=   40.07  STMD=  0.14  SAX= 15.00  TANSM=  0.42  SPLW=  0.07

24  AM     17.2    17.2    17.2    17.2    17.2    17.1      17.1    17.1    17.1    17.1    17.1    17.1
    PM     17.1    17.1    17.1    17.1    17.1    17.1      17.1    17.1    17.1    17.1    17.1    17.1     17.1
       MAXIMUM=    17.1  C.F.S.     TIME    11.15  A.M.
  24  SDEPTH=   41.15  STMD=  0.14  SAX= 15.00  TANSM=  0.43  SPLW=  0.07

25  AM     17.1    17.1    17.1    17.1    17.1    17.1      17.1    17.1    17.1    17.1    17.1    17.0
    PM     17.1    17.1    17.1    17.1    17.1    17.1      17.1    17.1    17.1    17.1    17.1    17.1     17.1
       MAXIMUM=    17.1  C.F.S.     TIME    11.15  A.M.
  25  SDEPTH=   41.05  STMD=  0.14  SAX= 15.00  TANSM=  0.45  SPLW=  0.07

26  AM     17.1    17.1    17.1    17.1    17.1    17.0      17.0    17.0    17.0    17.0    17.0    17.0
    PM     17.0    17.0    17.0    17.0    17.0    17.0      17.0    17.0    17.0    17.0    17.0    17.0     17.0
       MAXIMUM=    17.0  C.F.S.     TIME    11.15  A.M.
  26  SDEPTH=   40.95  STMD=  0.14  SAX= 15.00  TANSM=  0.44  SPLW=  0.07

27  AM     17.0    17.0    17.0    17.0    17.0    17.0      17.0    17.0    17.0    17.0    17.0    17.0
    PM     17.0    17.0    17.0    17.0    17.0    17.0      17.0    17.0    17.0    17.0    17.0    17.0     17.0
       MAXIMUM=    17.0  C.F.S.     TIME    11.15  A.M.
  27  SDEPTH=   40.84  STMD=  0.14  SAX= 15.00  TANSM=  0.44  SPLW=  0.07

28  AM     17.0    17.0    17.0    17.0    17.0    17.0      17.0    17.0    17.0    16.9    16.9    16.9
    PM     16.9    16.9    17.0    17.0    17.0    17.0      17.0    17.0    17.0    17.0    17.0    17.0     17.0
       MAXIMUM=    16.9  C.F.S.     TIME    11.15  A.M.
  28  SDEPTH=   40.74  STMD=  0.14  SAX= 15.00  TANSM=  0.44  SPLW=  0.07

29  AM     17.0    17.0    17.0    17.0    17.0    16.9      16.9    16.9    16.9    16.9    16.9    16.9
    PM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9     16.9
       MAXIMUM=    16.9  C.F.S.     TIME    11.15  A.M.
  29  SDEPTH=   40.64  STMD=  0.14  SAX= 15.00  TANSM=  0.44  SPLW=  0.07

30  AM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9
    PM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9     16.9
       MAXIMUM=    16.9  C.F.S.     TIME    11.15  A.M.
  30  SDEPTH=   40.53  STMD=  0.14  SAX= 15.00  TANSM=  0.43  SPLW=  0.07

31  AM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9
    PM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9     16.9
       MAXIMUM=    16.9  C.F.S.     TIME    11.15  A.M.
  31  SDEPTH=   40.42  STMD=  0.14  SAX= 15.00  TANSM=  0.43  SPLW=  0.07
JANUARY

 1  AM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9
    PM     16.9    16.9    16.9    16.9    16.9    16.9      16.9    16.9    16.9    16.9    16.9    16.9     16.9
       MAXIMUM=    16.9  C.F.S.     TIME    11.15  A.M.
   1  SDEPTH=   40.32  STMD=  0.14  SAX= 15.00  TANSM=  0.43  SPLW=  0.07
```

2 AM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
PM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
MAXIMUM= 16.9 C.F.S. TIME 11.15 A.M.
2 SDEPTH= 40.22 STMD= 0.13 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

3 AM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
PM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
MAXIMUM= 16.9 C.F.S. TIME 11.15 A.M.
3 SDEPTH= 40.13 STMD= 0.13 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

4 AM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
PM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
MAXIMUM= 16.9 C.F.S. TIME 11.15 A.M.
4 SDEPTH= 40.03 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

5 AM 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9
PM 16.9 16.9 16.9 16.9 16.9 17.0 17.0 17.0 17.0 17.0 17.0 17.0 16.9
MAXIMUM= 16.9 C.F.S. TIME 11.15 A.M.
5 SDEPTH= 39.94 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

6 AM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 16.9 16.9 16.9 16.9 16.9
PM 16.9 16.9 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0
MAXIMUM= 16.9 C.F.S. TIME 11.15 A.M.
6 SDEPTH= 39.84 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

7 AM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 16.9
PM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0
MAXIMUM= 17.0 C.F.S. TIME 11.15 A.M.
7 SDEPTH= 39.57 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

8 AM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0
PM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0
MAXIMUM= 17.0 C.F.S. TIME 11.15 A.M.
8 SDEPTH= 39.47 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

9 AM 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0
PM 17.0 17.0 17.0 17.0 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.0
MAXIMUM= 17.0 C.F.S. TIME 11.15 A.M.
9 SDEPTH= 39.37 STMD= 0.13 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

10 AM 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.0
PM 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1
MAXIMUM= 17.1 C.F.S. TIME 11.15 A.M.
10 SDEPTH= 39.27 STMD= 0.13 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

11 AM 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1
PM 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.1 17.2 17.2 17.2 17.2 17.1
MAXIMUM= 17.1 C.F.S. TIME 11.15 A.M.
11 SDEPTH= 39.18 STMD= 0.13 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

```
12 AM   17.2  17.2  17.2  17.2  17.2  17.2   17.2  17.1  17.1  17.1  17.1  17.1
   PM   17.1  17.1  17.2  17.2  17.2  17.2   17.2  17.2  17.2  17.2  17.2  17.2  17.2
     MAXIMUM=  17.1 C.F.S.   TIME  11.15 A.M.
 12 SDEPTH=  39.72 STMD=  0.13 SAX= 15.00 TANSM=  0.41  SPLW=  0.07

13 AM   17.2  17.2  17.2  17.2  17.2  17.2   17.2  17.2  17.2  17.2  17.2  17.2
   PM   17.2  17.2  17.2  17.2  17.2  17.2   17.2  17.2  17.2  17.2  17.3  17.3  17.2
     MAXIMUM=  17.2 C.F.S.   TIME  11.15 A.M.
 13 SDEPTH=  39.81 STMD=  0.13 SAX= 15.00 TANSM=  0.41  SPLW=  0.07

14 AM   17.3  17.3  17.3  17.3  17.3  17.2   17.2  17.2  17.2  17.2  17.2  17.2
   PM   17.2  17.2  17.3  17.3  17.3  17.3   17.3  17.3  17.3  17.3  17.3  17.3  17.3
     MAXIMUM=  17.2 C.F.S.   TIME  11.15 A.M.
 14 SDEPTH=  42.06 STMD=  0.13 SAX= 15.00 TANSM=  0.43  SPLW=  0.07

15 AM   17.3  17.3  17.3  17.3  17.3  17.3   17.3  17.3  17.3  17.3  17.3  17.3
   PM   17.3  17.3  17.3  17.3  17.3  17.3   17.3  17.3  17.3  17.4  17.4  17.4  17.3
     MAXIMUM=  17.3 C.F.S.   TIME  11.15 A.M.
 15 SDEPTH=  41.97 STMD=  0.13 SAX= 15.00 TANSM=  0.43  SPLW=  0.07

16 AM   17.4  17.4  17.4  17.4  17.4  17.4   17.4  17.3  17.3  17.3  17.3  17.3
   PM   17.3  17.4  17.4  17.4  17.4  17.4   17.4  17.4  17.4  17.4  17.4  17.4  17.4
     MAXIMUM=  17.3 C.F.S.   TIME  11.15 A.M.
 16 SDEPTH=  41.71 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07

17 AM   17.4  17.4  17.4  17.4  17.4  17.4   17.4  17.4  17.4  17.4  17.4  17.4
   PM   17.4  17.4  17.4  17.4  17.4  17.4   17.5  17.5  17.5  17.5  17.5  17.5  17.4
     MAXIMUM=  17.4 C.F.S.   TIME  11.15 A.M.
 17 SDEPTH=  41.61 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07

18 AM   17.5  17.5  17.5  17.5  17.5  17.5   17.5  17.5  17.5  17.5  17.5  17.4
   PM   17.5  17.5  17.5  17.5  17.5  17.5   17.5  17.5  17.5  17.5  17.5  17.5  17.5
     MAXIMUM=  17.5 C.F.S.   TIME  11.15 A.M.
 18 SDEPTH=  41.52 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07

19 AM   17.5  17.5  17.5  17.5  17.5  17.5   17.5  17.5  17.5  17.5  17.5  17.5
   PM   17.5  17.5  17.5  17.6  17.6  17.6   17.6  17.6  17.6  17.6  17.6  17.6  17.5
     MAXIMUM=  17.5 C.F.S.   TIME  11.15 A.M.
 19 SDEPTH=  41.57 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07

20 AM   17.6  17.6  17.6  17.6  17.6  17.6   17.6  17.6  17.6  17.6  17.6  17.6
   PM   17.6  17.6  17.6  17.6  17.6  17.6   17.6  17.6  17.7  17.7  17.7  17.7  17.6
     MAXIMUM=  17.6 C.F.S.   TIME  11.15 A.M.
 20 SDEPTH=  41.48 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07

21 AM   17.7  17.7  17.7  17.7  17.7  17.7   17.7  17.7  17.7  17.6  17.6  17.6
   PM   17.7  17.7  17.7  17.7  17.7  17.7   17.7  17.7  17.7  17.7  17.7  17.7  17.7
     MAXIMUM=  17.6 C.F.S.   TIME  11.15 A.M.
 21 SDEPTH=  41.40 STMD=  0.13 SAX= 15.00 TANSM=  0.42  SPLW=  0.07
```

22	AM	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	
	PM	17.7	17.7	17.7	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.7

MAXIMUM= 17.7 C.F.S. TIME 11.15 A.M.

22 SDEPTH= 41.31 STMD= 0.13 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

23	AM	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	
	PM	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.9	17.9	17.9	17.9	17.9	17.8

MAXIMUM= 17.8 C.F.S. TIME 11.15 A.M.

23 SDEPTH= 41.49 STMD= 0.13 SAX= 15.00 TANSM= 0.41 SPLW= 0.07

24	AM	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	
	PM	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9

MAXIMUM= 17.9 C.F.S. TIME 11.15 A.M.

24 SDEPTH= 42.14 STMD= 0.13 SAX= 15.00 TANSM= 0.42 SPLW= 0.07

25	AM	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	
	PM	17.9	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0

MAXIMUM= 17.9 C.F.S. TIME 11.15 A.M.

25 SDEPTH= 42.92 STMD= 0.13 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

26	AM	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	
	PM	18.0	18.0	18.0	18.0	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.0

MAXIMUM= 18.0 C.F.S. TIME 11.15 A.M.

26 SDEPTH= 42.84 STMD= 0.13 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

27	AM	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	18.1	
	PM	18.1	18.1	18.1	18.1	18.1	18.1	18.2	18.2	18.2	18.2	18.2	18.2	18.1

MAXIMUM= 18.1 C.F.S. TIME 11.15 A.M.

27 SDEPTH= 42.76 STMD= 0.13 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

28	AM	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	
	PM	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.3	18.3	18.3	18.2

MAXIMUM= 18.2 C.F.S. TIME 11.15 A.M.

28 SDEPTH= 45.33 STMD= 0.12 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

29	AM	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.2	18.2	18.2	
	PM	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3

MAXIMUM= 18.2 C.F.S. TIME 11.15 A.M.

29 SDEPTH= 45.30 STMD= 0.12 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

30	AM	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	
	PM	18.3	18.3	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4

MAXIMUM= 18.3 C.F.S. TIME 11.15 A.M.

30 SDEPTH= 45.25 STMD= 0.13 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

31	AM	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	
	PM	18.4	18.4	18.4	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.4

MAXIMUM= 18.4 C.F.S. TIME 11.15 A.M.

31 SDEPTH= 45.17 STMD= 0.13 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

FEBRUARY

1 AM 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5 18.5
PM 18.5 18.5 18.5 18.5 18.5 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.5
MAXIMUM= 18.5 C.F.S. TIME 11.15 A.M.
1 SDEPTH= 45.09 STMD= 0.13 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

2 AM 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.6 18.6
PM 18.6 18.6 18.6 18.6 18.6 18.6 18.7 18.7 18.7 18.7 18.7 18.7 18.6
MAXIMUM= 18.6 C.F.S. TIME 11.15 A.M.
2 SDEPTH= 45.01 STMD= 0.12 SAX= 15.00 TANSM= 0.44 SPLW= 0.07

3 AM 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7
PM 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.7 18.8 18.8 18.8 18.8 18.7
MAXIMUM= 18.7 C.F.S. TIME 11.15 A.M.
3 SDEPTH= 44.93 STMD= 0.12 SAX= 15.00 TANSM= 0.44 SPLW= 0.07

4 AM 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.7
PM 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.8 18.9 18.9 18.8
MAXIMUM= 18.8 C.F.S. TIME 11.15 A.M.
4 SDEPTH= 44.84 STMD= 0.13 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

5 AM 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.8 18.8 18.8
PM 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9
MAXIMUM= 18.9 C.F.S. TIME 11.15 A.M.
5 SDEPTH= 49.99 STMD= 0.13 SAX= 13.00 TANSM= 0.49 SPLW= 0.07

6 AM 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9 18.9
PM 18.9 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0
MAXIMUM= 18.9 C.F.S. TIME 11.15 A.M.
6 SDEPTH= 49.82 STMD= 0.12 SAX= 14.00 TANSM= 0.49 SPLW= 0.07

7 AM 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0 19.0
PM 19.0 19.0 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1
MAXIMUM= 19.0 C.F.S. TIME 11.15 A.M.
7 SDEPTH= 49.74 STMD= 0.12 SAX= 15.00 TANSM= 0.49 SPLW= 0.07

8 AM 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1 19.1
PM 19.1 19.1 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2
MAXIMUM= 19.1 C.F.S. TIME 11.15 A.M.
8 SDEPTH= 49.66 STMD= 0.12 SAX= 15.00 TANSM= 0.49 SPLW= 0.07

9 AM 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2 19.2
PM 19.2 19.2 19.2 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.3 19.2
MAXIMUM= 19.2 C.F.S. TIME 11.15 A.M.
9 SDEPTH= 49.70 STMD= 0.13 SAX= 14.00 TANSM= 0.51 SPLW= 0.07

10	AM	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	
	PM	19.3	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.3

MAXIMUM= 19.3 C.F.S. TIME 11.15 A.M.

10 SDEPTH= 49.63 STMD= 0.13 SAX= 15.00 TANSM= 0.51 SPLW= 0.07

11	AM	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	
	PM	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.4

MAXIMUM= 19.4 C.F.S. TIME 11.15 A.M.

11 SDEPTH= 49.56 STMD= 0.13 SAX= 15.00 TANSM= 0.51 SPLW= 0.07

12	AM	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	
	PM	19.5	19.5	19.5	19.5	19.5	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.5

MAXIMUM= 19.5 C.F.S. TIME 11.15 A.M.

12 SDEPTH= 49.48 STMD= 0.13 SAX= 15.00 TANSM= 0.51 SPLW= 0.07

13	AM	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6	
	PM	19.6	19.6	19.6	19.6	19.6	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.6

MAXIMUM= 19.6 C.F.S. TIME 11.15 A.M.

13 SDEPTH= 50.91 STMD= 0.13 SAX= 15.00 TANSM= 0.53 SPLW= 0.07

14	AM	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	19.7	
	PM	19.7	19.7	19.7	19.7	19.7	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.7

MAXIMUM= 19.7 C.F.S. TIME 11.15 A.M.

14 SDEPTH= 50.84 STMD= 0.13 SAX= 15.00 TANSM= 0.52 SPLW= 0.07

15	AM	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8	
	PM	19.8	19.8	19.8	19.8	19.8	19.8	19.9	19.9	19.9	19.9	19.9	19.9	19.8

MAXIMUM= 19.8 C.F.S. TIME 11.15 A.M.

15 SDEPTH= 50.77 STMD= 0.13 SAX= 15.00 TANSM= 0.52 SPLW= 0.07

16	AM	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	19.9	
	PM	19.9	19.9	19.9	19.9	19.9	19.9	20.0	20.0	20.0	20.0	20.0	20.0	19.9

MAXIMUM= 19.9 C.F.S. TIME 11.15 A.M.

16 SDEPTH= 50.63 STMD= 0.13 SAX= 15.00 TANSM= 0.52 SPLW= 0.07

17	AM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	
	PM	20.0	20.0	20.0	20.0	20.0	20.0	20.1	20.1	20.1	20.1	20.1	20.1	20.0

MAXIMUM= 20.0 C.F.S. TIME 11.15 A.M.

17 SDEPTH= 50.42 STMD= 0.13 SAX= 15.00 TANSM= 0.52 SPLW= 0.07

18	AM	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	
	PM	20.1	20.1	20.1	20.1	20.1	20.1	20.2	20.2	20.2	20.2	20.2	20.2	20.1

MAXIMUM= 20.1 C.F.S. TIME 11.15 A.M.

18 SDEPTH= 49.82 STMD= 0.13 SAX= 15.00 TANSM= 0.46 SPLW= 0.07

19	AM	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	
	PM	20.2	20.2	20.2	20.2	20.2	20.2	20.3	20.3	20.3	20.3	20.3	20.3	20.2

MAXIMUM= 20.2 C.F.S. TIME 11.15 A.M.

19 SDEPTH= 49.27 STMD= 0.13 SAX= 15.00 TANSM= 0.45 SPLW= 0.07

20	AM	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	19.7	19.7	19.7	19.7	
	PM	19.7	19.8	19.8	19.8	19.8	19.8	19.8	19.8	20.3	20.3	20.3	20.3	20.0

MAXIMUM= 19.7 C.F.S. TIME 11.15 A.M.

20 SDEPTH= 45.83 STMD= 0.14 SAX= 15.00 TANSM= 0.05 SPLW= 0.07

21	AM	20.3	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.1	20.1	20.1	20.1	
	PM	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1

MAXIMUM= 20.1 C.F.S. TIME 11.15 A.M.

21 SDEPTH= 45.32 STMD= 0.14 SAX= 15.00 TANSM= 0.21 SPLW= 0.07

22	AM	20.1	20.1	20.1	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	
	PM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0

MAXIMUM= 20.0 C.F.S. TIME 11.15 A.M.

22 SDEPTH= 44.61 STMD= 0.14 SAX= 15.00 TANSM= 0.25 SPLW= 0.07

23	AM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.9	19.9	19.9	19.9	
	PM	19.9	19.9	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0

MAXIMUM= 19.9 C.F.S. TIME 11.15 A.M.

23 SDEPTH= 44.30 STMD= 0.14 SAX= 15.00 TANSM= 0.34 SPLW= 0.07

24	AM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.9	
	PM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0

MAXIMUM= 20.0 C.F.S. TIME 11.15 A.M.

24 SDEPTH= 44.21 STMD= 0.14 SAX= 15.00 TANSM= 0.43 SPLW= 0.07

25	AM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	
	PM	20.0	20.0	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1

MAXIMUM= 20.0 C.F.S. TIME 11.15 A.M.

25 SDEPTH= 43.57 STMD= 0.16 SAX= 12.00 TANSM= 0.50 SPLW= 0.07

26	AM	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	
	PM	20.1	20.1	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2

MAXIMUM= 20.1 C.F.S. TIME 11.15 A.M.

26 SDEPTH= 46.21 STMD= 0.16 SAX= 11.00 TANSM= 0.56 SPLW= 0.07

27	AM	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	20.2	
	PM	20.2	20.2	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3	20.3

MAXIMUM= 20.2 C.F.S. TIME 11.15 A.M.

27 SDEPTH= 46.14 STMD= 0.16 SAX= 12.00 TANSM= 0.59 SPLW= 0.07

28	AM	20.3	20.3	20.3	20.4	20.4	20.4	20.3	20.3	20.3	20.3	20.3	20.3	
	PM	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.5	20.5	20.5	20.4

MAXIMUM= 20.3 C.F.S. TIME 11.15 A.M.

28 SDEPTH= 46.08 STMD= 0.16 SAX= 13.00 TANSM= 0.59 SPLW= 0.07

MARCH

1	AM	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	
	PM	20.5	20.5	20.5	20.5	20.5	20.5	20.6	20.6	20.6	20.6	20.6	20.6	20.5

MAXIMUM= 20.5 C.F.S. TIME 11.15 A.M.

1 SDEPTH= 46.01 STMD= 0.16 SAX= 14.00 TANSM= 0.58 SPLW= 0.07

2	AM	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	
	PM	20.6	20.6	20.6	20.6	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.6

MAXIMUM= 20.6 C.F.S. TIME 11.15 A.M.

2 SDEPTH= 45.93 STMD= 0.16 SAX= 15.00 TANSM= 0.58 SPLW= 0.07

3	AM	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	20.7	
	PM	20.7	20.7	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8

MAXIMUM= 20.7 C.F.S. TIME 11.15 A.M.

3 SDEPTH= 45.85 STMD= 0.16 SAX= 15.00 TANSM= 0.58 SPLW= 0.07

4	AM	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.8	20.8	
	PM	20.9	20.9	20.9	20.9	20.9	20.9	20.9	21.0	21.0	21.0	21.0	21.0	20.9

MAXIMUM= 20.8 C.F.S. TIME 11.15 A.M.

4 SDEPTH= 45.77 STMD= 0.16 SAX= 15.00 TANSM= 0.58 SPLW= 0.07

5	AM	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	
	PM	21.0	21.0	21.0	21.0	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.0

MAXIMUM= 21.0 C.F.S. TIME 11.15 A.M.

5 SDEPTH= 48.61 STMD= 0.15 SAX= 15.00 TANSM= 0.59 SPLW= 0.07

6	AM	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	
	PM	21.1	21.1	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2

MAXIMUM= 21.1 C.F.S. TIME 11.15 A.M.

6 SDEPTH= 48.53 STMD= 0.15 SAX= 15.00 TANSM= 0.59 SPLW= 0.07

7	AM	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	21.2	
	PM	21.2	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.4	21.4	21.4	21.3

MAXIMUM= 21.2 C.F.S. TIME 11.15 A.M.

7 SDEPTH= 50.81 STMD= 0.15 SAX= 15.00 TANSM= 0.61 SPLW= 0.07

8	AM	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4	
	PM	21.4	21.4	21.4	21.4	21.4	21.4	21.5	21.5	21.5	21.5	21.5	21.5	21.4

MAXIMUM= 21.4 C.F.S. TIME 11.15 A.M.

8 SDEPTH= 50.72 STMD= 0.15 SAX= 15.00 TANSM= 0.61 SPLW= 0.07

9	AM	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	
	PM	21.5	21.5	21.5	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.5

MAXIMUM= 21.5 C.F.S. TIME 11.15 A.M.

9 SDEPTH= 52.48 STMD= 0.15 SAX= 14.00 TANSM= 0.63 SPLW= 0.07

10	AM	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	
	PM	21.6	21.6	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7	21.7

MAXIMUM= 21.6 C.F.S. TIME 11.15 A.M.

10 SDEPTH= 52.39 STMD= 0.15 SAX= 15.00 TANSM= 0.63 SPLW= 0.07

11	AM	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.7	21.7	21.7	21.7	
	PM	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.9	21.9	21.9	21.9	21.8

MAXIMUM= 21.7 C.F.S. TIME 11.15 A.M.

11 SDEPTH= 52.49 STMD= 0.15 SAX= 15.00 TANSM= 0.64 SPLW= 0.07

12	AM	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	
	PM	21.9	21.9	21.9	21.9	21.9	22.0	22.0	22.0	22.0	22.0	22.0	22.0	21.9

MAXIMUM= 21.9 C.F.S. TIME 11.15 A.M.

12 SDEPTH= 52.40 STMD= 0.15 SAX= 15.00 TANSM= 0.64 SPLW= 0.07

13	AM	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	
	PM	22.0	22.0	22.0	22.0	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.0

MAXIMUM= 22.0 C.F.S. TIME 11.15 A.M.

13 SDEPTH= 52.30 STMD= 0.15 SAX= 15.00 TANSM= 0.64 SPLW= 0.07

14	AM	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	
	PM	22.1	22.1	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2	22.2

MAXIMUM= 22.1 C.F.S. TIME 11.15 A.M.

14 SDEPTH= 55.36 STMD= 0.15 SAX= 14.00 TANSM= 0.66 SPLW= 0.07

15	AM	22.2	22.2	22.2	22.3	22.3	22.2	22.2	22.2	22.2	22.2	22.2	22.2	
	PM	22.2	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.3	22.4	22.4	22.4	22.3

MAXIMUM= 22.2 C.F.S. TIME 11.15 A.M.

15 SDEPTH= 55.82 STMD= 0.15 SAX= 14.00 TANSM= 0.66 SPLW= 0.07

16	AM	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.3	
	PM	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.5	22.5	22.5	22.5	22.5	22.4

MAXIMUM= 22.4 C.F.S. TIME 11.15 A.M.

16 SDEPTH= 58.11 STMD= 0.16 SAX= 12.00 TANSM= 0.69 SPLW= 0.07

17	AM	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	
	PM	22.5	22.5	22.5	22.5	22.5	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.5

MAXIMUM= 22.5 C.F.S. TIME 11.15 A.M.

17 SDEPTH= 58.02 STMD= 0.16 SAX= 13.00 TANSM= 0.71 SPLW= 0.07

18	AM	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	
	PM	22.6	22.6	22.6	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.6

MAXIMUM= 22.6 C.F.S. TIME 11.15 A.M.

18 SDEPTH= 58.59 STMD= 0.16 SAX= 13.00 TANSM= 0.73 SPLW= 0.07

19	AM	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7	
	PM	22.7	22.7	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8	22.8

MAXIMUM= 22.7 C.F.S. TIME 11.15 A.M.

19 SDEPTH= 58.41 STMD= 0.16 SAX= 14.00 TANSM= 0.72 SPLW= 0.07

```
20 AM     22.8   22.8   22.9   22.9   22.9   22.8     22.8   22.8   22.8   22.8   22.8   22.8
   PM     22.8   22.9   22.9   22.9   22.9   22.9     22.9   22.9   22.9   23.0   23.0   23.0   22.9
      MAXIMUM=   22.8  C.F.S.    TIME   11.15  A.M.
 20  SDEPTH=  58.23  STMD=  0.16  SAX= 15.00  TANSM=  0.71  SPLW=  0.07

21 AM     23.0   23.0   23.0   23.0   23.0   23.0     23.0   23.0   23.0   23.0   22.9   22.9
   PM     23.0   23.0   23.0   23.0   23.0   23.0     23.0   23.1   23.1   23.1   23.1   23.1   23.0
      MAXIMUM=   22.9  C.F.S.    TIME   11.15  A.M.
 21  SDEPTH=  57.84  STMD=  0.16  SAX= 15.00  TANSM=  0.68  SPLW=  0.07

22 AM     23.1   23.1   23.1   23.1   23.1   23.1     23.1   23.1   23.1   23.1   23.1   23.1
   PM     23.1   23.1   23.1   23.1   23.1   23.1     23.2   23.2   23.2   23.2   23.2   23.2   23.1
      MAXIMUM=   23.1  C.F.S.    TIME   11.15  A.M.
 22  SDEPTH=  56.71  STMD=  0.17  SAX= 14.00  TANSM=  0.70  SPLW=  0.07

23 AM     23.2   23.2   23.2   23.2   23.2   23.2     23.2   23.2   23.2   23.2   23.2   23.2
   PM     23.2   23.2   23.2   23.2   23.2   23.3     23.3   23.3   23.3   23.3   23.3   23.3   23.2
      MAXIMUM=   23.2  C.F.S.    TIME   11.15  A.M.
 23  SDEPTH=  56.51  STMD=  0.17  SAX= 15.00  TANSM=  0.65  SPLW=  0.07

24 AM     23.3   23.3   23.3   23.3   23.3   23.3     23.3   23.3   23.3   23.3   23.3   23.3
   PM     23.3   23.3   23.3   23.3   23.4   23.4     23.4   23.4   23.4   23.4   23.4   23.4   23.3
      MAXIMUM=   23.3  C.F.S.    TIME   11.15  A.M.
 24  SDEPTH=  56.15  STMD=  0.17  SAX= 15.00  TANSM=  0.51  SPLW=  0.07

25 AM     23.4   23.4   23.4   23.4   23.4   23.4     23.4   23.4   23.4   23.4   23.4   23.4
   PM     23.4   23.4   23.4   23.5   23.5   23.5     23.5   23.5   23.5   23.5   23.5   23.5   23.4
      MAXIMUM=   23.4  C.F.S.    TIME   11.15  A.M.
 25  SDEPTH=  55.84  STMD=  0.17  SAX= 15.00  TANSM=  0.56  SPLW=  0.07

26 AM     23.5   23.5   23.5   23.5   23.5   23.5     23.5   23.5   23.5   23.5   23.5   23.5
   PM     23.5   23.5   23.5   23.6   23.6   23.6     23.6   23.6   23.6   23.6   23.6   23.6   23.5
      MAXIMUM=   23.5  C.F.S.    TIME   11.15  A.M.
 26  SDEPTH=  56.00  STMD=  0.17  SAX= 15.00  TANSM=  0.60  SPLW=  0.07

27 AM     23.6   23.6   23.6   23.6   23.6   23.6     23.6   23.6   23.6   23.6   23.6   23.6
   PM     23.6   23.6   23.7   23.7   23.7   23.7     23.7   23.7   23.7   23.7   23.7   23.7   23.7
      MAXIMUM=   23.6  C.F.S.    TIME   11.15  A.M.
 27  SDEPTH=  55.91  STMD=  0.17  SAX= 15.00  TANSM=  0.64  SPLW=  0.07

28 AM     23.7   23.7   23.7   23.7   23.7   23.7     23.7   23.7   23.7   23.7   23.7   23.7
   PM     23.7   23.7   23.8   23.8   23.8   23.8     23.8   23.8   23.8   23.8   23.8   23.8   23.8
      MAXIMUM=   23.7  C.F.S.    TIME   11.15  A.M.
 28  SDEPTH=  57.34  STMD=  0.18  SAX= 12.00  TANSM=  0.66  SPLW=  0.07

29 AM     23.8   23.8   23.8   23.8   23.8   23.8     23.8   23.8   23.8   23.8   23.8   23.8
   PM     23.8   23.8   23.9   23.9   23.9   23.9     23.9   23.9   23.9   23.9   23.9   23.9   23.9
      MAXIMUM=   23.8  C.F.S.    TIME   11.15  A.M.
 29  SDEPTH=  57.18  STMD=  0.18  SAX= 13.00  TANSM=  0.67  SPLW=  0.07
```

```
30  AM      23.9    23.9    23.9    23.9    23.9    23.9     23.9    23.9    23.9    23.9    23.9    23.9
    PM      23.9    23.9    24.0    24.0    24.0    24.0     24.0    24.0    24.0    24.0    24.0    24.0    24.0
       MAXIMUM=     23.9  C.F.S.      TIME    11.15  A.M.
 30  SDEPTH=   57.06  STMD=  0.18  SAX= 14.00  TANSM=  0.69  SPLW=  0.07

31  AM      24.0    24.0    24.0    24.0    24.0    24.0     24.0    24.0    24.0    24.0    24.0    24.0
    PM      24.0    24.0    24.0    24.1    24.1    24.1     24.1    24.1    24.1    24.1    24.1    24.1    24.1
       MAXIMUM=     24.0  C.F.S.      TIME    11.15  A.M.
 31  SDEPTH=   57.06  STMD=  0.18  SAX= 15.00  TANSM=  0.72  SPLW=  0.07
APRIL

 1  AM      24.1    24.1    24.1    24.1    24.1    24.1     24.1    24.1    24.1    24.1    24.1    24.1
    PM      24.1    24.1    24.1    24.2    24.2    24.2     24.2    24.2    24.2    24.2    24.2    24.2    24.1
       MAXIMUM=     24.1  C.F.S.      TIME    11.15  A.M.
  1  SDEPTH=   56.97  STMD=  0.18  SAX= 15.00  TANSM=  0.74  SPLW=  0.07

 2  AM      24.2    24.2    24.2    24.2    24.2    24.2     24.2    24.2    24.2    24.2    24.2    24.2
    PM      24.2    24.2    24.2    24.3    24.3    24.3     24.3    24.3    24.3    24.3    24.3    24.3    24.2
       MAXIMUM=     24.2  C.F.S.      TIME    11.15  A.M.
  2  SDEPTH=   60.15  STMD=  0.18  SAX= 13.00  TANSM=  0.75  SPLW=  0.07

 3  AM      24.3    24.3    24.3    24.3    24.3    24.3     24.3    24.3    24.3    24.3    24.3    24.3
    PM      24.3    24.3    24.3    24.3    24.4    24.4     24.4    24.4    24.4    24.4    24.4    24.4    24.3
       MAXIMUM=     24.3  C.F.S.      TIME    11.15  A.M.
  3  SDEPTH=   60.05  STMD=  0.18  SAX= 14.00  TANSM=  0.77  SPLW=  0.07

 4  AM      24.4    24.4    24.4    24.4    24.4    24.4     24.4    24.4    24.4    24.4    24.4    24.4
    PM      24.4    24.4    24.4    24.4    24.4    24.5     24.5    24.5    24.5    24.5    24.5    24.5    24.4
       MAXIMUM=     24.4  C.F.S.      TIME    11.15  A.M.
  4  SDEPTH=   67.64  STMD=  0.17  SAX= 10.00  TANSM=  0.78  SPLW=  0.07

 5  AM      24.5    24.5    24.5    24.5    24.5    24.5     24.5    24.5    24.5    24.5    24.5    24.5
    PM      24.5    24.5    24.5    24.5    24.5    24.5     24.6    24.6    24.6    24.6    24.6    24.6    24.5
       MAXIMUM=     24.5  C.F.S.      TIME    11.15  A.M.
  5  SDEPTH=   67.53  STMD=  0.17  SAX= 11.00  TANSM=  0.80  SPLW=  0.07

 6  AM      24.6    24.6    24.6    24.6    24.6    24.6     24.6    24.6    24.6    24.6    24.6    24.5
    PM      24.6    24.6    24.6    24.6    24.6    24.6     24.6    24.7    24.7    24.7    24.7    24.7    24.6
       MAXIMUM=     24.6  C.F.S.      TIME    11.15  A.M.
  6  SDEPTH=   67.35  STMD=  0.17  SAX= 12.00  TANSM=  0.80  SPLW=  0.07

 7  AM      24.7    24.7    24.7    24.7    24.7    24.7     24.7    24.7    24.7    24.7    24.6    24.6
    PM      24.7    24.7    24.7    24.7    24.7    24.7     24.7    24.7    24.7    24.8    24.8    24.8    24.7
       MAXIMUM=     24.7  C.F.S.      TIME    11.15  A.M.
  7  SDEPTH=   67.22  STMD=  0.17  SAX= 13.00  TANSM=  0.80  SPLW=  0.07

 8  AM      24.8    24.8    24.8    24.8    24.8    24.8     24.8    24.7    24.7    24.7    24.7    24.7
    PM      24.7    24.8    24.8    24.8    24.8    24.8     24.8    24.8    24.8    24.8    24.8    24.8    24.8
       MAXIMUM=     24.7  C.F.S.      TIME    11.15  A.M.
  8  SDEPTH=   68.51  STMD=  0.19  SAX=  9.00  TANSM=  0.82  SPLW=  0.07
```

9	AM	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	24.8	
	PM	24.8	24.8	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9

MAXIMUM= 24.8 C.F.S. TIME 11.15 A.M.

9 SDEPTH= 68.31 STMD= 0.19 SAX= 9.00 TANSM= 0.83 SPLW= 0.07

10	AM	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9	
	PM	24.9	24.9	24.9	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	24.9

MAXIMUM= 24.9 C.F.S. TIME 11.15 A.M.

10 SDEPTH= 68.20 STMD= 0.19 SAX= 10.00 TANSM= 0.84 SPLW= 0.07

11	AM	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	
	PM	25.0	25.0	25.0	25.0	25.0	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.0

MAXIMUM= 25.0 C.F.S. TIME 11.15 A.M.

11 SDEPTH= 69.12 STMD= 0.19 SAX= 9.00 TANSM= 0.85 SPLW= 0.07

12	AM	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1	
	PM	25.1	25.1	25.1	25.1	25.1	25.1	25.2	25.2	25.2	25.2	25.2	25.2	25.1

MAXIMUM= 25.1 C.F.S. TIME 11.15 A.M.

12 SDEPTH= 71.00 STMD= 0.19 SAX= 9.00 TANSM= 0.86 SPLW= 0.07

13	AM	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.1	25.1	
	PM	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.3	25.3	25.3	25.2

MAXIMUM= 25.1 C.F.S. TIME 11.15 A.M.

13 SDEPTH= 70.90 STMD= 0.19 SAX= 10.00 TANSM= 0.87 SPLW= 0.07

14	AM	25.3	25.3	25.3	25.3	25.3	25.3	25.2	25.2	24.3	24.3	24.2	24.2	
	PM	24.3	24.3	24.3	24.3	24.3	24.3	24.3	24.2	25.2	25.2	25.1	25.1	24.7

MAXIMUM= 24.2 C.F.S. TIME 11.15 A.M.

14 SDEPTH= 69.41 STMD= 0.19 SAX= 11.00 TANSM= 0.69 SPLW= 0.07

15	AM	25.1	25.1	25.0	25.0	25.0	24.9	24.9	24.9	23.9	23.8	23.8	23.8	
	PM	23.8	23.8	23.7	23.7	23.7	23.7	23.6	23.6	24.5	24.5	24.5	24.4	24.3

MAXIMUM= 23.8 C.F.S. TIME 11.15 A.M.

15 SDEPTH= 67.84 STMD= 0.20 SAX= 12.00 TANSM= 0.46 SPLW= 0.07

16	AM	24.4	24.4	24.3	24.3	24.2	24.2	24.2	24.1	23.1	23.1	23.0	23.0	
	PM	23.0	22.9	22.9	22.9	22.8	22.8	22.8	22.7	23.7	23.6	23.6	23.5	23.5

MAXIMUM= 23.0 C.F.S. TIME 11.15 A.M.

16 SDEPTH= 66.42 STMD= 0.20 SAX= 13.00 TANSM= 0.27 SPLW= 0.07

17	AM	23.5	23.4	23.4	23.3	23.3	23.3	23.2	23.2	22.2	22.1	22.1	22.0	
	PM	22.0	22.0	21.9	21.9	21.9	21.8	21.8	21.7	22.6	22.6	22.6	22.5	22.5

MAXIMUM= 22.1 C.F.S. TIME 11.15 A.M.

17 SDEPTH= 64.05 STMD= 0.21 SAX= 14.00 TANSM= 0.01 SPLW= 0.15

18	AM	22.5	22.4	22.4	22.3	22.3	22.2	22.2	22.2	21.1	21.1	21.0	21.0	
	PM	21.0	20.9	20.9	20.8	20.8	20.8	20.7	20.7	21.6	21.6	21.5	21.5	21.5

MAXIMUM= 21.0 C.F.S. TIME 11.15 A.M.

18 SDEPTH= 62.15 STMD= 0.21 SAX= 15.00 TANSM= 0.03 SPLW= 0.35

19	AM	21.4	21.4	21.3	21.3	21.3	21.2	21.2	21.1	20.1	20.1	20.0	20.0	
	PM	19.9	19.9	19.8	19.8	19.8	19.7	19.7	19.6	20.6	20.5	20.5	20.4	20.4

MAXIMUM= 20.0 C.F.S. TIME 11.15 A.M.

19 SDEPTH= 60.80 STMD= 0.22 SAX= 15.00 TANSM= 0.04 SPLW= 0.46

20	AM	20.4	20.4	20.3	20.3	20.2	20.2	20.1	20.1	19.1	19.0	19.0	18.9	
	PM	18.9	18.9	18.8	18.8	18.7	18.7	18.7	18.6	19.6	19.5	19.5	19.4	19.4

MAXIMUM= 19.0 C.F.S. TIME 11.15 A.M.

20 SDEPTH= 59.72 STMD= 0.22 SAX= 15.00 TANSM= 0.04 SPLW= 0.48

21	AM	19.4	19.3	19.3	19.3	19.2	19.2	19.1	19.1	17.9	17.9	17.8	17.8	
	PM	17.8	17.7	17.7	17.6	17.6	17.6	17.5	17.5	18.6	18.5	18.5	18.5	18.4

MAXIMUM= 18.6 C.F.S. TIME 8.15 P.M.

21 SDEPTH= 58.68 STMD= 0.22 SAX= 15.00 TANSM= 0.03 SPLW= 0.50

22	AM	18.4	18.4	18.3	18.3	18.3	18.2	18.2	18.1	17.0	16.9	16.9	16.9	
	PM	16.8	16.8	16.7	17.2	18.3	20.5	24.2	28.9	35.1	39.3	41.1	40.4	22.1

MAXIMUM= 41.5 C.F.S. TIME 10.45 P.M.

22 SDEPTH= 57.13 STMD= 0.22 SAX= 15.00 TANSM= 0.03 SPLW= 0.49

23	AM	38.1	34.9	31.9	29.5	27.8	26.7	25.8	25.2	23.7	23.3	23.1	22.9	
	PM	22.7	22.6	22.5	22.3	22.9	24.3	26.4	29.2	33.1	36.1	37.8	37.5	27.9

MAXIMUM= 39.0 C.F.S. TIME 0.15 A.M.

23 SDEPTH= 55.84 STMD= 0.23 SAX= 15.00 TANSM= 0.04 SPLW= 0.49

24	AM	35.7	33.4	31.6	30.3	29.4	28.7	28.2	27.9	26.4	26.2	26.0	25.8	
	PM	25.7	25.6	25.5	25.4	25.3	25.2	25.0	24.9	26.0	25.9	25.8	25.7	27.3

MAXIMUM= 36.5 C.F.S. TIME 0.15 A.M.

24 SDEPTH= 54.74 STMD= 0.23 SAX= 15.00 TANSM= 0.01 SPLW= 0.49

25	AM	25.6	25.5	25.5	25.4	25.3	25.2	25.1	25.1	25.0	24.9	24.8	24.8	
	PM	24.7	24.6	24.6	24.5	24.4	24.4	24.3	24.3	24.2	24.1	24.1	24.0	24.8

MAXIMUM= 25.7 C.F.S. TIME 0.15 A.M.

25 SDEPTH= 54.56 STMD= 0.23 SAX= 15.00 TANSM= 0.23 SPLW= 0.49

26	AM	24.0	23.9	23.9	23.8	23.8	23.7	23.6	23.6	23.5	23.5	23.4	23.4	
	PM	23.3	23.3	23.3	23.2	23.2	23.1	23.1	23.1	23.0	23.0	23.0	22.9	23.4

MAXIMUM= 24.0 C.F.S. TIME 0.15 A.M.

26 SDEPTH= 54.25 STMD= 0.23 SAX= 15.00 TANSM= 0.31 SPLW= 0.49

27	AM	22.9	22.9	22.8	22.8	22.7	22.7	22.7	22.6	22.6	22.6	22.5	22.5	
	PM	22.5	22.5	22.4	22.4	22.4	22.4	22.4	22.3	22.3	22.3	22.3	22.2	22.5

MAXIMUM= 22.9 C.F.S. TIME 0.15 A.M.

27 SDEPTH= 54.07 STMD= 0.23 SAX= 15.00 TANSM= 0.39 SPLW= 0.49

28	AM	22.2	22.2	22.2	22.2	22.1	22.1	22.1	22.1	22.0	22.0	22.0	22.0	
	PM	22.0	22.0	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	21.9	22.0

MAXIMUM= 22.2 C.F.S. TIME 0.15 A.M.

28 SDEPTH= 53.98 STMD= 0.23 SAX= 15.00 TANSM= 0.48 SPLW= 0.49

29 AM 21.8 21.8 21.8 21.8 21.8 21.8 21.8 21.8 21.7 21.7 21.7 21.7
PM 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.7 21.8 21.8 21.7
MAXIMUM= 21.9 C.F.S. TIME 0.15 A.M.
29 SDEPTH= 54.24 STMD= 0.24 SAX= 15.00 TANSM= 0.07 SPLW= 0.51

30 AM 21.8 21.8 21.8 21.8 21.8 21.8 21.7 21.7 20.5 20.5 20.5 20.5
PM 20.6 20.6 20.6 20.6 20.6 20.6 20.6 20.6 21.7 21.7 21.7 21.7 21.2
MAXIMUM= 21.8 C.F.S. TIME 3.15 A.M.
30 SDEPTH= 54.92 STMD= 0.24 SAX= 15.00 TANSM= 0.08 SPLW= 0.51

MAY

1 AM 21.6 21.8 22.0 22.1 22.3 22.4 22.6 22.7 22.8 22.9 23.0 23.1
PM 23.2 23.4 23.5 23.6 23.8 23.9 24.0 24.1 24.2 24.2 24.3 24.4 23.2
MAXIMUM= 23.0 C.F.S. TIME 11.15 A.M.
1 SDEPTH= 54.44 STMD= 0.24 SAX= 15.00 TANSM= 0.19 SPLW= 0.51

2 AM 24.5 24.6 24.6 24.7 24.7 24.8 24.8 24.9 23.6 23.7 23.7 23.7
PM 23.8 23.9 24.0 24.0 24.1 24.1 24.1 24.1 25.4 25.3 25.3 25.3 24.4
MAXIMUM= 23.7 C.F.S. TIME 11.15 A.M.
2 SDEPTH= 53.30 STMD= 0.25 SAX= 15.00 TANSM= 0.06 SPLW= 0.51

3 AM 25.3 25.3 25.3 25.3 25.2 25.2 25.2 25.2 23.9 23.8 23.8 23.8
PM 23.8 23.8 23.8 23.8 24.0 25.6 27.6 30.8 35.8 39.5 43.1 44.3 27.6
MAXIMUM= 44.6 C.F.S. TIME 11.45 P.M.
3 SDEPTH= 51.89 STMD= 0.25 SAX= 15.00 TANSM= 0.03 SPLW= 0.50

4 AM 43.5 41.4 38.9 37.0 35.6 34.6 33.9 33.4 31.7 31.4 31.1 31.0
PM 30.8 32.6 36.3 42.2 50.5 61.3 74.3 86.8 97.5 103.2 105.3 104.5 52.0
MAXIMUM= 105.7 C.F.S. TIME 10.45 P.M.
4 SDEPTH= 49.83 STMD= 0.25 SAX= 15.00 TANSM= 0.01 SPLW= 0.49

5 AM 101.3 96.6 91.5 87.0 83.4 80.8 78.8 77.3 74.7 73.7 72.8 72.0
PM 72.1 75.0 79.5 86.9 96.9 109.7 124.1 136.8 147.8 154.1 157.1 157.0 99.4
MAXIMUM= 157.3 C.F.S. TIME 11.15 P.M.
5 SDEPTH= 47.58 STMD= 0.26 SAX= 15.00 TANSM= 0.0 SPLW= 0.47

6 AM 154.3 149.8 144.3 138.8 134.0 130.2 127.2 124.8 121.6 119.9 118.4 118.9
PM 121.8 126.9 135.1 146.4 160.8 176.2 190.3 202.5 213.8 221.1 225.9 227.9 155.5
MAXIMUM= 227.3 C.F.S. TIME 11.45 P.M.
6 SDEPTH= 44.93 STMD= 0.26 SAX= 15.00 TANSM= 0.0 SPLW= 0.45

7 AM 227.6 225.1 221.2 216.6 211.9 207.8 204.6 202.8 201.2 202.9 206.4 213.0
PM 220.6 230.6 242.1 254.5 267.0 277.7 287.1 295.0 301.9 304.5 304.0 300.8 242.9
MAXIMUM= 304.6 C.F.S. TIME 10.15 P.M.
7 SDEPTH= 42.34 STMD= 0.26 SAX= 15.00 TANSM= 0.03 SPLW= 0.42

8 AM 295.4 288.5 281.2 274.5 269.0 264.5 260.6 257.1 252.8 249.9 247.3 244.8
PM 242.4 240.1 237.9 237.4 238.4 240.3 243.6 247.6 253.1 255.8 255.8 253.2 255.5
MAXIMUM= 297.6 C.F.S. TIME 0.15 A.M.
8 SDEPTH= 41.00 STMD= 0.26 SAX= 15.00 TANSM= 0.04 SPLW= 0.41

```
 9  AM     249.1   244.3   240.0   236.3   233.2   230.6     228.2   226.1   222.7   220.9   219.0   217.3
    PM     215.7   214.1   212.5   211.0   211.1   212.5     214.9   218.3   223.5   227.3   229.8   229.3   224.5
      MAXIMUM=   250.8  C.F.S.     TIME    0.15  A.M.
  9  SDEPTH=   39.62  STMD=  0.27  SAX= 15.00  TANSM=  0.03  SPLW=  0.40

10  AM     226.7   222.9   218.9   215.5   212.8   210.6     208.6   206.8   204.0   202.5   201.1   199.8
    PM     198.5   197.3   198.5   201.7   206.7   214.0     223.4   234.2   244.9   250.4   252.3   251.1   216.8
      MAXIMUM=   253.0  C.F.S.     TIME   10.45  P.M.
 10  SDEPTH=   37.88  STMD=  0.27  SAX= 15.00  TANSM=  0.03  SPLW=  0.39

11  AM     247.5   242.5   237.2   232.6   229.0   226.0     223.6   221.5   218.0   216.4   214.9   213.4
    PM     212.1   210.8   212.7   221.4   237.0   268.0     333.6   452.3   619.1   809.9  1004.9  1149.6   352.3
      MAXIMUM=  1184.7  C.F.S.     TIME   12.00  P.M.
 11  SDEPTH=   35.28  STMD=  0.27  SAX= 15.00  TANSM=  0.0   SPLW=  0.37

12  AM    1243.2  1313.2  1356.9  1380.6  1389.4  1386.3    1377.4  1365.3  1349.2  1332.9  1315.0  1295.9
    PM    1276.3  1258.6  1241.3  1225.3  1210.7  1197.3    1185.1  1171.9  1158.4  1141.4  1122.9  1103.1  1266.6
      MAXIMUM=  1391.2  C.F.S.     TIME    4.45  A.M.
 12  SDEPTH=   34.40  STMD=  0.28  SAX= 15.00  TANSM=  0.04  SPLW=  0.37

13  AM    1082.4  1061.6  1041.4  1022.1  1003.8   986.2     969.3   953.0   935.5   920.1   905.2   890.7
    PM     876.5   862.7   849.2   836.1   823.8   813.8     804.6   796.5   790.8   783.5   776.1   766.6   898.0
      MAXIMUM=  1090.2  C.F.S.     TIME    0.15  A.M.
 13  SDEPTH=   32.93  STMD=  0.28  SAX= 15.00  TANSM=  0.03  SPLW=  0.36

14  AM     755.1   742.5   729.7   717.6   706.2   695.4     685.1   675.2   663.9   654.6   645.5   636.7
    PM     628.1   619.7   612.9   608.3   605.8   604.8     605.4   607.2   609.8   607.7   602.6   594.9   650.6
      MAXIMUM=   759.7  C.F.S.     TIME    0.15  A.M.
 14  SDEPTH=   31.28  STMD=  0.29  SAX= 15.00  TANSM=  0.03  SPLW=  0.35

15  AM     585.5   575.3   565.4   556.3   548.1   540.6     533.5   526.8   518.7   512.5   506.6   500.7
    PM     495.1   489.6   487.9   487.7   489.9   494.6     501.6   510.3   518.4   520.9   519.7   515.4   520.9
      MAXIMUM=   589.3  C.F.S.     TIME    0.15  A.M.
 15  SDEPTH=   29.37  STMD=  0.29  SAX= 15.00  TANSM=  0.01  SPLW=  0.33

16  AM     508.7   500.4   491.6   483.4   476.2   469.8     464.1   458.9   452.3   447.6   443.1   438.8
    PM     434.7   433.4   434.2   437.1   442.3   449.9     459.5   468.1   475.2   476.8   475.3   471.0   462.2
      MAXIMUM=   511.6  C.F.S.     TIME    0.15  A.M.
 16  SDEPTH=   27.79  STMD=  0.30  SAX= 15.00  TANSM=  0.03  SPLW=  0.32

17  AM     464.7   457.2   449.6   442.8   437.0   431.9     427.4   423.2   417.7   414.1   410.6   407.2
    PM     407.7   410.9   417.5   428.1   442.8   461.5     480.8   497.5   512.3   520.8   524.5   523.9   450.5
      MAXIMUM=   525.4  C.F.S.     TIME   10.45  P.M.
 17  SDEPTH=   25.19  STMD=  0.30  SAX= 15.00  TANSM=  0.01  SPLW=  0.29

18  AM     519.6   512.6   504.0   495.3   487.6   481.1     475.4   470.3   464.1   459.8   455.8   452.9
    PM     454.4   460.5   468.7   482.7   501.1   523.3     545.1   561.4   574.8   582.3   585.2   583.9   504.2
```

```
              MAXIMUM=   585.9  C.F.S.      TIME   10.45  P.M.
   18  SDEPTH=    22.63  STMD=  0.30  SAX= 15.00  TANSM=  0.0   SPLW=  0.27

 19  AM     579.2    571.8    563.0    553.9    545.6    538.5     532.2    526.6    519.8    515.0    510.5    510.6
     PM     512.9    519.0    529.3    544.2    563.2    582.8     600.7    616.2    630.1    638.3    642.0    641.2    561.9
              MAXIMUM=   642.5  C.F.S.      TIME   10.45  P.M.
   19  SDEPTH=    19.98  STMD=  0.31  SAX= 15.00  TANSM=  0.0   SPLW=  0.24

 20  AM     636.9    629.6    620.5    611.0    602.0    594.2     587.4    581.2    573.9    568.7    563.7    564.5
     PM     567.9    577.4    593.4    617.1    649.1    687.5     729.6    771.0    812.7    847.7    877.2    898.4    656.8
              MAXIMUM=   904.1  C.F.S.      TIME   12.00  P.M.
   20  SDEPTH=    17.19  STMD=  0.31  SAX= 15.00  TANSM=  0.01  SPLW=  0.21

 21  AM     905.9    903.1    894.2    882.9    871.5    860.8     850.5    840.7    829.1    819.9    810.9    804.1
     PM     801.5    801.3    805.3    813.4    825.6    840.9     858.1    873.1    889.2    898.9    905.6    908.8    854.0
              MAXIMUM=   910.6  C.F.S.      TIME   11.45  P.M.
   21  SDEPTH=    14.72  STMD=  0.32  SAX= 15.00  TANSM=  0.0   SPLW=  0.18

 22  AM     906.0    897.8    885.6    872.6    860.5    849.4     839.2    829.6    818.5    809.9    801.5    796.9
     PM     795.1    796.4    801.5    810.7    823.6    837.8     850.7    861.5    871.3    875.0    874.5    870.3    843.2
              MAXIMUM=   908.3  C.F.S.      TIME    0.15  A.M.
   22  SDEPTH=    12.46  STMD=  0.33  SAX= 15.00  TANSM=  0.0   SPLW=  0.16

 23  AM     862.8    852.9    841.5    830.0    819.4    809.7     800.9    792.7    779.7    772.3    765.3    762.6
     PM     762.4    765.6    775.4    789.4    807.6    828.0     847.6    865.4    882.7    887.7    887.5    883.4    819.7
              MAXIMUM=   888.4  C.F.S.      TIME   10.45  P.M.
   23  SDEPTH=    10.23  STMD=  0.33  SAX= 15.00  TANSM=  0.0   SPLW=  0.13

 24  AM     876.2    866.6    855.8    844.8    834.4    825.0     816.4    808.4    795.5    788.3    781.4    779.9
     PM     780.0    783.7    791.3    802.9    817.3    831.4     843.4    852.8    864.4    867.2    866.4    862.4    826.5
              MAXIMUM=   879.7  C.F.S.      TIME    0.15  A.M.
   24  SDEPTH=     8.01  STMD=  0.34  SAX= 15.00  TANSM=  0.0   SPLW=  0.11

 25  AM     855.4    846.5    836.4    825.8    815.5    806.0     797.4    789.6    778.2    774.0    771.5    772.7
     PM     774.9    780.1    786.8    794.0    800.0    804.2     807.0    808.4    813.2    810.6    805.8    799.2    802.2
              MAXIMUM=   858.9  C.F.S.      TIME    0.15  A.M.
   25  SDEPTH=     6.39  STMD=  0.34  SAX= 15.00  TANSM=  0.0   SPLW=  0.08

 26  AM     791.3    782.5    773.5    764.8    756.8    749.7     743.3    737.5    726.7    721.5    716.5    713.9
     PM     712.8    713.3    715.7    720.0    724.8    729.6     732.9    734.5    739.4    737.1    732.9    727.1    737.4
              MAXIMUM=   795.1  C.F.S.      TIME    0.15  A.M.
   26  SDEPTH=     5.02  STMD=  0.35  SAX= 15.00  TANSM=  0.0   SPLW=  0.07

 27  AM     720.4    713.0    705.6    698.6    692.3    686.9     681.9    677.4    668.0    664.0    660.1    656.5
     PM     652.9    651.4    650.8    651.5    652.5    655.1     659.4    660.7    666.2    664.5    661.2    656.6    671.1
              MAXIMUM=   723.7  C.F.S.      TIME    0.15  A.M.
   27  SDEPTH=     3.94  STMD=  0.37  SAX= 15.00  TANSM=  0.0   SPLW=  0.06
```

28	AM	651.2	645.4	639.6	634.4	629.8	625.8	622.2	618.9	610.5	607.5	604.6	601.9	
	PM	599.2	596.6	595.8	595.4	595.4	596.7	598.9	601.5	608.0	607.6	605.6	602.5	612.3
	MAXIMUM= 653.9 C.F.S. TIME 0.15 A.M.													
28	SDEPTH= 3.00 STMD= 0.39 SAX= 15.00 TANSM= 0.0 SPLW= 0.05													
29	AM	598.5	594.1	589.5	585.2	581.2	577.7	574.7	571.9	564.1	561.7	559.6	559.8	
	PM	559.5	560.6	562.3	564.8	566.9	567.3	566.8	565.7	569.2	566.7	563.6	560.1	570.5
	MAXIMUM= 600.9 C.F.S. TIME 0.15 A.M.													
29	SDEPTH= 2.31 STMD= 0.39 SAX= 15.00 TANSM= 0.0 SPLW= 0.03													
30	AM	556.4	552.6	549.1	546.1	543.4	541.1	538.9	536.8	529.6	527.8	526.0	524.2	
	PM	522.5	520.8	519.1	517.5	515.5	513.9	512.3	510.7	514.5	512.9	511.4	509.8	527.2
	MAXIMUM= 558.5 C.F.S. TIME 0.15 A.M.													
30	SDEPTH= 1.82 STMD= 0.42 SAX= 15.00 TANSM= 0.0 SPLW= 0.03													
31	AM	508.3	506.8	505.3	503.8	502.3	500.9	499.4	498.0	490.6	489.2	487.8	486.4	
	PM	485.0	483.6	482.2	480.9	479.3	477.9	476.6	475.3	479.9	478.6	477.3	476.0	488.8
	MAXIMUM= 509.5 C.F.S. TIME 0.15 A.M.													
31	SDEPTH= 1.50 STMD= 0.46 SAX= 15.00 TANSM= 0.0 SPLW= 0.03													
JUNE														
1	AM	474.7	473.5	472.2	470.9	469.7	468.5	467.2	466.0	458.8	457.6	456.4	455.2	
	PM	454.0	452.8	451.6	450.4	449.0	447.9	446.7	445.6	450.4	449.3	448.1	447.0	457.6
	MAXIMUM= 475.8 C.F.S. TIME 0.15 A.M.													
1	SDEPTH= 1.19 STMD= 0.49 SAX= 15.00 TANSM= 0.0 SPLW= 0.02													
2	AM	445.9	444.8	443.7	442.6	441.5	440.4	439.3	438.2	431.2	430.1	429.0	428.0	
	PM	426.9	425.8	424.8	423.8	422.5	421.5	420.4	419.4	424.4	423.3	422.3	421.3	430.5
	MAXIMUM= 446.9 C.F.S. TIME 0.15 A.M.													
2	SDEPTH= 0.97 STMD= 0.50 SAX= 15.00 TANSM= 0.0 SPLW= 0.02													
3	AM	420.3	419.3	418.3	417.3	416.3	415.4	414.4	413.4	406.5	405.5	404.5	403.6	
	PM	402.6	401.7	400.7	399.8	398.6	397.7	396.7	395.8	400.8	399.9	399.0	398.1	406.1
	MAXIMUM= 421.3 C.F.S. TIME 0.15 A.M.													
3	SDEPTH= 0.80 STMD= 0.52 SAX= 15.00 TANSM= 0.0 SPLW= 0.02													
4	AM	397.1	396.2	395.3	394.4	393.5	392.6	391.7	390.8	383.9	383.1	382.2	381.3	
	PM	380.4	379.5	378.6	377.8	376.7	375.8	375.0	374.1	379.2	378.4	377.5	376.7	383.8
	MAXIMUM= 398.0 C.F.S. TIME 0.15 A.M.													
4	SDEPTH= 0.61 STMD= 0.54 SAX= 15.00 TANSM= 0.0 SPLW= 0.01													
5	AM	375.8	375.0	374.1	373.3	372.4	371.6	370.8	369.9	363.1	362.3	361.5	360.7	
	PM	359.8	363.2	366.9	373.3	389.9	401.3	411.4	405.5	403.2	398.5	395.6	392.9	379.1
	MAXIMUM= 414.5 C.F.S. TIME 6.45 P.M.													
5	SDEPTH= 0.41 STMD= 0.51 SAX= 15.00 TANSM= 0.0 SPLW= 0.01													

```
 6  AM     389.6   382.8   376.5   373.4   371.3   373.9     378.1   388.0   394.8   404.5   413.4   417.7
    PM     423.4   419.9   418.9   419.0   417.9   416.5     408.1   398.5   394.0   388.5   384.4   381.3   397.3
       MAXIMUM=    421.1  C.F.S.       TIME      1.15  P.M.
   6  SDEPTH=    0.27  STMD=  0.46  SAX= 15.00  TANSM=  0.0   SPLW=  0.00

 7  AM     378.8   376.7   375.0   373.5   372.1   370.8     369.7   368.5   361.5   360.4   359.4   358.4
    PM     357.4   356.4   355.4   354.4   353.3   352.3     351.3   350.4   355.4   354.5   353.6   352.6   361.3
       MAXIMUM=    380.1  C.F.S.       TIME      0.15  A.M.
   7  SDEPTH=    0.08  STMD=  0.49  SAX= 15.00  TANSM=  0.0   SPLW=  0.00

 8  AM     351.7   350.8   349.9   349.0   348.1   347.2     346.3   345.4   338.6   337.7   336.8   335.9
    PM     335.1   334.2   333.4   332.5   331.5   330.7     329.8   329.0   334.2   333.3   332.5   331.7   338.5
       MAXIMUM=    352.5  C.F.S.       TIME      0.15  A.M.

 9  AM     330.9   330.1   329.3   328.5   327.7   326.9     326.1   325.3   318.5   317.8   317.0   316.2
    PM     315.4   314.7   313.9   313.1   312.2   311.5     310.7   310.0   315.2   314.5   313.7   313.0   318.8
       MAXIMUM=    331.6  C.F.S.       TIME      0.15  A.M.

10  AM     312.3   311.5   310.8   310.1   309.3   308.6     307.9   307.2   299.0   298.2   297.5   296.8
    PM     296.1   295.4   294.7   294.0   293.2   292.5     291.8   291.1   298.0   297.3   296.6   295.9   300.3
       MAXIMUM=    313.0  C.F.S.       TIME      0.15  A.M.

11  AM     295.3   294.6   293.9   293.3   292.6   291.9     291.3   290.6   282.4   281.8   281.1   280.5
    PM     279.8   279.2   278.5   277.9   277.1   276.5     275.8   275.2   282.1   281.5   280.8   280.2   283.9
       MAXIMUM=    295.9  C.F.S.       TIME      0.15  A.M.

12  AM     279.6   278.9   278.3   277.7   277.1   276.5     275.8   275.2   267.1   266.5   265.9   265.3
    PM     264.7   264.1   263.4   262.8   262.1   261.5     260.9   260.3   267.3   266.7   266.1   265.5   268.7
       MAXIMUM=    280.2  C.F.S.       TIME      0.15  A.M.

13  AM     264.9   264.3   263.8   263.2   262.6   262.0     261.4   260.9   252.8   252.2   251.6   251.0
    PM     250.5   249.9   249.3   248.8   248.1   247.5     247.0   246.4   253.4   252.8   252.3   251.7   254.5
       MAXIMUM=    265.5  C.F.S.       TIME      0.15  A.M.

14  AM     251.2   250.6   250.1   249.5   249.0   248.4     247.9   247.4   239.3   238.7   238.2   237.7
    PM     237.1   236.6   236.1   235.5   234.9   234.4     233.8   233.3   240.3   239.8   239.3   238.8   241.2
       MAXIMUM=    251.7  C.F.S.       TIME      0.15  A.M.

15  AM     238.2   237.7   237.2   236.7   236.2   235.6     235.1   234.6   226.6   226.1   225.6   225.1
    PM     224.5   224.0   223.5   223.0   222.4   221.9     221.4   220.8   227.8   227.3   226.8   226.4   228.5
       MAXIMUM=    238.7  C.F.S.       TIME      0.15  A.M.
```

C-4

JULY

6	AM	79.7	79.5	79.3	79.2	79.0	78.8	78.7	78.5	71.0	70.8	70.7	70.5	
	PM	70.3	70.2	70.0	69.8	69.8	70.5	72.7	74.6	83.8	85.2	83.0	80.7	75.7
	MAXIMUM=	85.9	C.F.S.	TIME	9.45	P.M.								
7	AM	79.0	77.8	76.9	76.3	75.9	75.4	75.1	74.8	67.3	67.0	66.8	66.6	
	PM	66.6	67.8	71.4	74.3	78.2	80.9	78.5	74.6	78.9	76.8	75.2	74.2	74.0
	MAXIMUM=	81.9	C.F.S.	TIME	5.45	P.M.								
8	AM	73.4	72.8	72.3	72.0	71.7	71.4	71.2	71.0	63.4	63.3	63.1	63.0	
	PM	62.8	62.7	62.5	62.4	62.2	62.1	61.9	61.8	68.9	68.8	68.6	68.5	66.7
	MAXIMUM=	73.7	C.F.S.	TIME	0.15	A.M.								
18	AM	42.9	42.3	42.7	42.6	42.5	42.4	42.3	42.2	34.5	34.4	34.3	34.2	
	PM	34.1	34.1	34.9	37.4	40.2	44.4	47.9	47.8	54.7	51.5	48.4	46.2	41.6
	MAXIMUM=	55.2	C.F.S.	TIME	8.15	P.M.								
19	AM	44.7	43.4	42.5	41.8	41.3	40.9	40.7	40.4	32.6	32.4	32.3	32.1	
	PM	32.0	31.9	31.9	31.8	31.7	31.6	31.5	31.4	39.0	39.0	38.9	38.8	36.4
	MAXIMUM=	45.2	C.F.S.	TIME	0.15	A.M.								
25	AM	29.9	29.8	29.8	29.7	29.6	29.6	29.5	29.5	22.2	22.2	22.1	22.1	
	PM	22.0	21.9	21.9	21.8	21.7	21.7	21.7	22.6	33.7	40.0	45.7	50.8	28.0
	MAXIMUM=	52.1	C.F.S.	TIME	12.00	P.M.								
26	AM	52.0	46.1	40.4	36.6	33.9	32.0	30.8	29.9	22.1	21.6	21.3	21.0	
	PM	20.8	20.7	20.6	20.4	20.3	20.3	20.2	20.2	27.2	27.2	27.1	27.1	27.5
	MAXIMUM=	52.7	C.F.S.	TIME	0.45	A.M.								
30	AM	23.1	23.1	23.0	23.0	22.9	22.9	22.8	22.8	18.7	18.6	18.6	18.5	
	PM	19.1	25.6	44.4	62.6	82.1	98.6	88.7	73.4	61.3	49.0	40.6	34.8	39.1
	MAXIMUM=	102.9	C.F.S.	TIME	5.45	P.M.								
31	AM	30.8	28.0	26.1	24.8	23.8	23.2	22.7	22.4	18.1	17.9	17.8	17.7	
	PM	17.5	17.4	17.4	17.3	17.3	17.3	17.2	17.2	21.2	21.1	21.1	21.1	20.7
	MAXIMUM=	32.1	C.F.S.	TIME	0.15	A.M.								

AUGUST

3	AM	18.9	18.9	18.9	18.8	18.8	18.7	18.7	18.7	14.6	14.5	14.5	14.4	
	PM	14.4	14.4	14.3	14.4	16.0	20.8	27.9	34.4	43.7	44.0	38.2	32.0	21.8
	MAXIMUM=	44.6	C.F.S.	TIME	8.45	P.M.								
4	AM	27.6	24.0	22.5	21.0	20.0	19.3	18.8	18.5	14.1	13.9	13.8	13.7	
	PM	13.7	15.2	20.1	26.3	33.9	41.8	43.1	40.7	40.1	33.6	28.4	24.9	24.6
	MAXIMUM=	43.4	C.F.S.	TIME	6.45	P.M.								
5	AM	22.5	20.8	19.6	18.8	18.2	17.8	17.5	17.3	13.1	13.0	12.9	12.8	
	PM	12.7	12.7	12.6	12.6	12.9	16.2	27.7	44.9	69.9	93.5	106.1	104.6	30.4
	MAXIMUM=	108.4	C.F.S.	TIME	10.45	P.M.								

6	AM	95.6	81.6	63.1	48.5	38.5	31.6	26.9	23.6	17.3	15.7	14.7	13.9	
	PM	13.4	13.0	12.8	12.6	12.4	12.3	12.2	12.1	16.1	16.1	16.1	16.0	26.5
		MAXIMUM=	99.4	C.F.S.	TIME	0.15	A.M.							
10	AM	13.7	13.7	13.6	13.6	13.6	13.5	13.5	13.5	7.8	7.7	7.7	7.7	
	PM	7.6	7.6	7.6	7.6	7.8	11.7	28.1	59.3	97.9	127.6	142.0	123.7	32.0
		MAXIMUM=	146.2	C.F.S.	TIME	10.45	P.M.							
11	AM	92.2	67.5	50.5	38.8	30.8	25.3	21.6	19.0	11.5	10.2	9.4	8.8	
	PM	8.4	8.1	7.9	7.7	7.6	7.5	7.4	7.3	13.0	13.0	12.9	12.9	20.8
		MAXIMUM=	103.7	C.F.S.	TIME	0.15	A.M.							
12	AM	12.9	12.8	12.8	13.0	14.2	17.3	20.9	24.3	24.9	26.8	26.2	26.0	
	PM	26.2	22.1	18.2	15.6	14.1	13.7	13.7	13.8	16.8	15.8	14.7	14.0	17.9
		MAXIMUM=	27.2	C.F.S.	TIME	9.45	A.M.							
13	AM	13.5	13.1	12.9	12.7	12.6	12.5	12.4	12.2	6.5	6.5	6.5	6.7	
	PM	8.2	12.5	16.2	19.7	22.7	19.5	16.1	14.8	19.8	19.7	19.9	17.9	14.0
		MAXIMUM=	23.6	C.F.S.	TIME	4.45	P.M.							
14	AM	16.0	14.7	13.8	13.2	12.8	12.5	12.3	12.1	6.3	6.2	6.1	6.0	
	PM	6.0	6.0	5.9	5.9	5.9	5.9	5.8	5.8	11.5	11.5	11.4	11.4	9.4
		MAXIMUM=	16.6	C.F.S.	TIME	0.15	A.M.							
16	AM	10.8	10.8	10.8	10.8	10.7	10.7	10.7	10.7	4.9	4.9	4.9	4.9	
	PM	4.9	4.9	5.7	8.1	10.7	13.0	15.1	14.1	18.7	21.2	26.3	37.0	11.9
		MAXIMUM=	41.1	C.F.S.	TIME	12.00	P.M.							
17	AM	46.4	49.7	51.4	41.4	31.7	25.1	20.5	17.3	9.5	8.0	7.0	6.3	
	PM	5.8	5.4	5.2	5.0	4.9	4.8	4.7	4.6	10.2	10.2	10.2	10.2	16.5
		MAXIMUM=	52.8	C.F.S.	TIME	2.45	A.M.							
19	AM	9.7	9.6	9.6	9.6	9.6	9.5	9.5	9.5	6.2	6.2	6.2	6.1	
	PM	6.2	6.8	8.6	11.5	16.7	21.1	23.0	23.7	22.6	18.4	15.6	13.6	12.0
		MAXIMUM=	24.6	C.F.S.	TIME	8.15	P.M.							
20	AM	12.2	11.3	10.6	10.2	9.9	9.6	9.5	9.4	6.0	5.9	5.8	5.8	
	PM	5.8	5.8	5.7	5.7	5.7	5.7	5.7	5.6	8.9	8.9	8.9	8.8	7.8
		MAXIMUM=	12.7	C.F.S.	TIME	0.15	A.M.							
21	AM	8.8	8.8	8.8	8.8	8.7	8.7	8.7	8.7	5.4	5.4	5.4	5.3	
	PM	5.3	5.4	6.4	9.4	13.7	21.1	29.2	37.1	49.4	54.7	62.0	67.3	18.9
		MAXIMUM=	68.5	C.F.S.	TIME	12.00	P.M.							
22	AM	69.6	70.0	69.5	65.5	59.6	55.0	47.8	39.3	29.0	22.6	18.2	15.2	
	PM	13.1	11.6	10.7	10.0	9.5	9.2	8.9	8.8	10.3	10.2	10.1	10.0	28.5
		MAXIMUM=	69.9	C.F.S.	TIME	1.15	A.M.							

23	AM	10.0	10.0	9.9	9.9	9.9	9.9	9.9	9.9	6.6	6.5	6.5	6.5	
	PM	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3	9.6	9.6	9.6	9.5	8.1
	MAXIMUM=		6.4	C.F.S.	TIME	4.15	P.M.							
SEPTEMBER														
4	AM	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.3	1.0	1.0	1.0	1.0	
	PM	1.0	1.0	1.1	2.3	4.3	6.0	7.6	8.0	10.5	8.8	7.7	6.9	4.7
	MAXIMUM=		11.3	C.F.S.	TIME	8.15	P.M.							
5	AM	6.3	6.0	5.7	5.5	5.4	5.3	5.2	5.1	0.8	0.3	0.8	0.9	
	PM	2.2	6.0	11.8	19.5	28.3	34.9	38.2	37.6	38.3	32.0	24.3	18.2	14.1
	MAXIMUM=		39.9	C.F.S.	TIME	8.15	P.M.							
6	AM	14.1	11.2	9.3	7.9	7.0	6.4	5.9	5.6	1.1	1.0	0.9	0.8	
	PM	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	4.8	4.8	4.8	4.8	4.0
	MAXIMUM=		15.4	C.F.S.	TIME	0.15	A.M.							
8	AM	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.5	1.0	0.9	0.9	0.9	
	PM	0.9	0.9	1.0	1.5	2.9	4.9	7.3	9.2	13.1	12.2	10.0	8.2	4.7
	MAXIMUM=		13.3	C.F.S.	TIME	8.45	P.M.							
9	AM	7.0	6.2	5.6	5.2	4.9	4.7	4.6	4.5	0.9	0.8	0.7	0.7	
	PM	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	4.2	4.2	4.1	4.1	2.8
	MAXIMUM=		7.4	C.F.S.	TIME	0.15	A.M.							
10	AM	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	0.5	0.5	0.5	0.5	
	PM	0.5	0.5	0.5	0.5	0.5	0.6	1.7	5.4	13.4	18.5	23.9	24.4	5.2
	MAXIMUM=		25.0	C.F.S.	TIME	10.45	P.M.							
11	AM	22.2	19.1	14.8	11.4	9.1	7.4	6.3	5.6	1.5	1.2	0.9	0.7	
	PM	0.6	0.5	0.5	0.3	0.3	0.3	0.3	0.7	6.0	9.5	13.9	17.8	6.3
	MAXIMUM=		23.1	C.F.S.	TIME	0.15	A.M.							
12	AM	19.9	18.9	14.8	11.4	9.0	7.3	6.2	5.4	1.4	1.0	0.8	0.6	
	PM	0.5	0.4	0.3	0.2	0.2	1.1	10.2	37.5	71.9	110.6	151.9	162.2	26.8
	MAXIMUM=		162.3	C.F.S.	TIME	12.00	P.M.							
13	AM	162.7	154.9	138.5	116.8	93.1	68.2	49.0	35.7	23.0	16.7	12.4	9.4	
	PM	7.4	6.0	5.0	4.4	3.9	3.6	3.4	3.2	6.6	6.5	6.5	6.4	39.3
	MAXIMUM=		163.5	C.F.S.	TIME	0.45	A.M.							
14	AM	9.2	16.1	35.7	52.9	69.2	83.3	69.7	52.5	38.5	30.0	24.3	21.0	
	PM	20.1	22.5	27.1	33.8	41.6	46.5	49.1	48.5	47.2	41.9	34.8	29.1	39.4
	MAXIMUM=		87.5	C.F.S.	TIME	5.45	A.M.							
14	SDEPTH=	0.02	STMD=	0.39	SAX=	15.00	TANSM=	0.00	SPLW=	0.00				
15	AM	25.1	22.3	20.4	19.1	18.1	17.5	17.0	16.7	12.9	12.7	12.6	12.5	
	PM	12.4	12.4	13.0	13.9	15.7	17.2	18.6	19.2	21.2	19.6	18.5	17.7	16.9
	MAXIMUM=		26.3	C.F.S.	TIME	0.15	A.M.							

16	AM	17.1	16.7	16.5	16.2	16.1	16.0	15.9	15.8	14.0	13.9	13.9	13.9	
	PM	13.8	13.8	13.8	13.7	13.7	13.7	13.6	13.6	15.3	15.3	15.3	15.2	14.9
		MAXIMUM=	17.3	C.F.S.	TIME	0.15	A.M.							
16	SDEPTH=	0.33	STMD=	0.03	SAX= 15.00	TANSM=	0.00	SPLW=	0.0					
17	AM	15.2	15.1	15.1	15.1	15.0	15.0	15.0	15.0	11.4	11.4	11.3	11.3	
	PM	11.3	11.3	11.2	11.2	11.2	11.1	11.1	11.1	14.5	14.5	14.5	14.4	13.1
		MAXIMUM=	15.2	C.F.S.	TIME	0.15	A.M.							
18	AM	14.4	14.3	14.3	14.3	14.2	14.2	14.2	14.1	11.0	10.9	10.9	10.9	
	PM	10.8	10.9	11.6	13.2	16.4	20.2	24.3	27.2	30.1	27.6	24.2	21.4	16.5
		MAXIMUM=	30.5	C.F.S.	TIME	8.15	P.M.							
19	AM	19.5	18.2	17.3	16.7	16.3	16.0	15.8	15.6	12.4	12.3	12.3	12.3	
	PM	12.2	12.2	12.2	12.2	13.1	14.5	18.1	21.9	29.2	32.8	32.0	29.3	17.7
		MAXIMUM=	33.5	C.F.S.	TIME	9.45	P.M.							
20	AM	26.0	23.3	21.4	20.2	19.3	18.7	18.3	18.0	14.7	14.6	14.5	14.4	
	PM	14.4	14.3	14.3	14.3	14.3	14.2	14.2	14.2	17.3	17.2	17.2	17.2	16.9
		MAXIMUM=	27.1	C.F.S.	TIME	0.15	A.M.							
21	AM	17.1	17.1	17.1	17.1	17.0	17.0	17.0	17.0	13.8	13.8	13.8	13.7	
	PM	13.7	13.7	13.7	13.6	13.6	13.6	13.5	13.5	16.6	16.5	16.5	16.5	15.3
		MAXIMUM=	17.2	C.F.S.	TIME	0.15	A.M.							
22	AM	16.4	16.4	16.4	16.3	16.3	16.3	16.2	16.2	13.1	13.0	13.0	13.0	
	PM	12.9	12.9	12.9	12.8	12.8	12.8	12.7	12.7	15.7	15.7	15.7	15.6	14.5
		MAXIMUM=	16.5	C.F.S.	TIME	0.15	A.M.							
23	AM	15.6	15.6	15.5	15.5	15.5	15.4	15.4	15.3	12.2	12.2	12.1	12.1	
	PM	12.1	12.0	12.0	12.0	12.0	12.4	13.6	16.0	22.6	26.8	30.7	33.0	16.1
		MAXIMUM=	33.5	C.F.S.	TIME	11.45	P.M.							
24	AM	33.0	31.9	31.2	30.0	32.1	35.9	40.3	46.7	46.9	48.7	51.3	50.9	
	PM	49.0	44.5	39.6	34.9	30.2	26.6	24.1	22.3	22.6	21.8	21.2	20.8	34.9
		MAXIMUM=	51.6	C.F.S.	TIME	10.45	A.M.							
25	AM	20.5	20.3	20.1	20.0	19.9	19.8	19.7	19.6	16.5	16.4	16.4	16.3	
	PM	16.3	16.2	16.2	16.2	16.1	16.1	16.0	16.0	19.0	19.0	18.9	18.9	17.9
		MAXIMUM=	20.6	C.F.S.	TIME	0.15	A.M.							
26	AM	18.8	18.8	18.7	18.7	18.6	18.6	18.5	18.5	15.3	15.3	15.3	15.2	
	PM	15.2	15.1	15.1	15.0	15.0	14.9	14.9	14.9	17.9	17.9	17.8	17.8	16.7
		MAXIMUM=	18.9	C.F.S.	TIME	0.15	A.M.							
27	AM	17.7	17.7	17.6	17.6	17.6	17.5	17.5	17.4	14.3	14.2	14.2	14.2	
	PM	14.1	14.1	14.0	14.0	13.9	13.9	13.9	13.8	16.9	16.8	16.8	16.8	15.7
		MAXIMUM=	17.8	C.F.S.	TIME	0.15	A.M.							
28	AM	16.7	16.7	16.6	16.6	16.6	16.5	16.5	16.4	13.0	13.0	12.9	12.9	
	PM	12.9	12.8	12.8	13.1	13.6	14.6	15.5	16.4	20.1	19.2	18.2	17.5	15.5
		MAXIMUM=	20.3	C.F.S.	TIME	8.45	P.M.							
29	AM	17.0	16.7	16.4	16.2	16.0	15.9	15.8	15.7	12.2	12.2	12.2	12.1	
	PM	12.1	12.1	12.0	12.0	12.0	11.9	11.9	11.9	15.2	15.2	15.2	15.1	14.0
		MAXIMUM=	17.2	C.F.S.	TIME	0.15	A.M.							

YEARLY STATISTICAL SUMMARY

	MONTHLY REFERENCE	MONTHLY SIMULATED	DAILY REFERENCE	DAILY SIMULATED
MEAN	2405.60	2432.44	79.09	79.97
MAXIMUM	14092.04	15398.39	919.23	1266.56
VARIANCE	18195728.00	20465536.00	25021.94	28993.11
STANDARD DEVIATION	4265.64	4523.89	158.18	170.27

	MONTHLY	DAILY
SUM OF (REFERENCE - SIMULATED)	-322.07	-322.04
ROOT SUM SQUARE	1510.44	506.55
SUM SQUARED	0.04	1.78
SUM SQUARED (IBM METHOD)	0.03	1.47
CORRELATION COEFFICIENT	0.9964	0.9896

SUMMARY OF MONTHLY AND ANNUAL TOTALS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL	
PRECIPITATION	3.870	4.280	1.390	1.020	2.530	3.980	4.430	2.250	0.930	1.080	3.690	3.930	33.380	IN
EVP/TRAN-NET	0.970	0.0	0.0	0.0	0.016	0.0	0.363	2.265	5.091	3.805	3.360	2.556	18.425	IN
-POTENTIAL	1.071	0.0	0.0	0.0	0.016	0.0	0.363	2.265	6.126	6.167	3.360	2.570	21.938	IN
SURFACE RUNOFF	0.017	0.002	0.000	0.000	0.000	0.000	0.003	0.179	0.015	0.012	0.047	0.049	0.323	IN
INTERFLOW	0.003	0.001	0.0	0.0	0.0	0.0	0.003	1.877	0.019	0.000	0.000	0.006	1.908	IN
BASE FLOW	0.182	0.151	0.195	0.188	0.191	0.241	0.242	3.311	2.556	0.555	0.128	0.113	8.054	IN
STREAM EVAP.	0.007	0.0	0.0	0.0	0.000	0.0	0.002	0.014	0.037	0.039	0.023	0.018	0.139	IN
TOTAL RUNOFF(SIM)	0.195	0.154	0.195	0.188	0.191	0.241	0.246	5.352	2.552	0.529	0.152	0.150	10.145	IN
TOTAL RUNOFF(REF)	0.197	0.158	0.195	0.189	0.192	0.243	0.244	4.898	2.809	0.585	0.164	0.159	10.033	IN
REFERENCE TOTALS	567.2	454.3	561.6	545.0	552.3	697.9	701.8	14092.0	8082.1	1682.9	472.9	457.1	28867.2	CFS
SIMULATED TOTALS	562.5	442.9	560.4	541.7	548.7	693.2	708.5	15398.4	7342.7	1521.9	437.9	430.6	29189.3	CFS

BALANCE -0.0597 INCHES

MONTHLY FLOW CORRELATION COEFFICIENT 0.9964
MEAN DAILY FLOW CORRELATION COEFFICIENT 0.9896

MEAN DAILY REFERENCE FLOWS (CFS)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
1	25.6	18.9	17.5	17.0	18.7	20.7	24.3	24.0	502.3	107.3	20.5	4.6	
2	24.3	19.6	19.8	17.0	18.8	20.8	24.4	25.4	474.5	101.7	19.3	4.3	
3	24.8	17.7	20.1	17.0	18.8	20.9	24.5	28.2	448.8	96.3	23.6	3.9	
4	22.5	17.5	20.1	17.0	18.9	21.0	24.5	49.3	424.9	91.3	26.3	5.2	
5	20.6	17.2	19.9	17.0	19.0	21.2	24.6	86.0	418.1	86.5	32.1	14.6	
6	19.9	17.0	19.7	17.0	19.1	21.3	24.7	132.0	431.7	83.5	28.1	4.4	
7	19.0	16.7	19.5	17.1	19.2	21.4	24.8	205.4	392.6	81.4	15.1	3.0	
8	17.4	16.5	19.3	17.1	19.3	21.6	24.9	214.6	370.0	73.8	14.2	5.1	
9	16.5	16.2	19.0	17.1	19.4	21.7	25.0	199.6	349.7	69.7	12.6	3.2	
10	18.1	15.9	18.8	17.2	19.5	21.8	25.1	201.5	330.2	65.8	33.3	5.6	
11	15.7	15.7	18.6	17.2	19.6	21.9	25.1	316.8	312.7	62.3	22.0	6.6	
12	20.6	15.4	18.4	17.3	19.7	22.1	25.2	919.2	296.2	58.9	19.1	27.2	
13	17.9	15.2	18.3	17.3	19.8	22.2	25.3	679.5	280.7	55.8	15.1	39.6	
14	14.9	15.0	18.1	17.4	19.9	22.3	24.8	534.9	266.0	52.8	10.5	38.7	
15	13.1	14.8	18.0	17.4	20.0	22.4	24.3	460.8	252.1	49.9	9.3	17.0	
16	12.1	14.6	17.8	17.5	20.1	22.6	23.4	430.5	239.1	47.2	12.9	16.0	
17	21.2	14.4	17.7	17.5	20.2	22.7	22.3	433.2	226.7	44.6	17.4	14.7	
18	12.4	14.2	17.6	17.6	20.3	22.8	21.3	478.8	214.9	45.8	8.0	18.3	
19	12.9	14.1	17.5	17.7	20.4	22.9	20.2	527.6	203.8	40.4	12.9	19.5	
20	23.0	13.9	17.4	17.7	20.2	23.0	19.2	609.1	192.9	38.0	8.6	18.8	
21	26.1	13.8	17.3	17.8	20.2	23.1	18.1	737.3	182.8	35.9	19.7	17.3	
22	20.5	13.7	17.3	17.9	20.1	23.3	21.6	749.3	173.3	33.9	29.4	16.4	
23	18.8	13.6	17.2	17.9	20.0	23.4	26.0	753.1	164.3	32.0	9.0	17.9	
24	18.2	13.5	17.1	18.0	20.1	23.5	25.1	770.0	155.7	30.2	8.5	35.8	
25	17.5	13.4	17.1	18.1	20.2	23.6	23.3	766.0	147.6	30.9	8.0	18.8	
26	16.5	13.3	17.1	18.2	20.3	23.7	22.5	727.6	139.9	30.3	7.5	17.8	
27	16.3	13.3	17.0	18.3	20.4	23.8	22.1	683.2	132.6	25.4	7.1	16.9	
28	15.0	13.2	17.0	18.3	20.5	23.9	21.8	640.0	125.6	23.9	6.6	16.7	
29	14.9	13.1	17.0	18.4		24.0	21.8	607.3	119.1	23.6	5.7	15.2	
30	14.4	13.1	17.0	18.5		24.1	21.6	568.7	113.2	41.3	5.3	14.3	
31	16.3		17.0	18.6		24.2		532.9		22.8	5.0		
REFERENCE TOTALS	567.2	454.3	561.6	545.0	552.3	697.9	701.8	14092.0	8082.1	1682.9	472.9	457.1	28867.2 CFS

MEAN DAILY SIMULATED FLOWS (CFS)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
1	25.6	18.5	16.7	16.9	18.5	20.5	24.1	23.2	457.6	97.1	18.5	4.0	
2	24.3	19.4	19.3	16.9	18.6	20.6	24.2	24.4	430.5	92.0	17.4	3.7	
3	24.8	17.3	19.9	16.9	18.7	20.8	24.3	27.6	406.1	87.2	21.8	3.4	
4	22.5	17.0	20.0	16.9	18.8	20.9	24.4	52.0	383.8	82.6	24.6	4.7	
5	20.6	16.7	19.9	16.9	18.9	21.0	24.5	99.4	379.1	78.2	30.4	14.1	
6	19.9	16.4	19.8	17.0	19.0	21.2	24.6	155.5	397.3	75.7	26.5	4.0	
7	19.1	16.1	19.6	17.0	19.1	21.3	24.7	242.8	361.3	74.0	13.6	2.5	
8	17.4	15.9	19.4	17.0	19.2	21.4	24.8	255.5	338.5	66.7	12.8	4.7	
9	16.5	15.7	19.1	17.0	19.2	21.5	24.9	224.5	318.8	63.0	11.2	2.8	
10	18.1	15.4	18.9	17.1	19.3	21.7	24.9	216.8	300.3	59.5	32.0	5.2	
11	15.7	15.2	18.7	17.1	19.4	21.8	25.0	352.3	283.9	56.3	20.8	6.3	
12	20.6	15.0	18.5	17.2	19.5	21.9	25.1	1266.6	268.7	53.2	17.9	26.8	
13	17.9	14.8	18.4	17.2	19.6	22.0	25.2	898.0	254.5	50.3	14.0	39.3	
14	14.9	14.6	18.2	17.3	19.7	22.2	24.7	650.6	241.2	47.6	9.4	39.4	
15	13.1	14.4	18.0	17.3	19.8	22.3	24.3	520.9	228.5	45.0	8.3	16.9	
16	12.1	14.2	17.9	17.4	19.9	22.4	23.5	462.2	216.5	42.5	11.9	14.9	
17	21.2	14.0	17.8	17.4	20.0	22.5	22.5	450.5	205.3	40.2	16.5	13.1	
18	12.4	13.9	17.6	17.5	20.1	22.6	21.5	504.2	194.7	41.6	7.1	16.5	
19	12.9	13.7	17.5	17.5	20.2	22.8	20.4	561.9	184.6	36.4	12.0	17.7	
20	22.9	13.6	17.4	17.6	20.0	22.9	19.4	656.8	174.7	34.2	7.8	16.9	
21	26.5	13.5	17.3	17.7	20.1	23.0	18.4	854.0	165.6	32.3	18.9	15.3	
22	20.7	13.4	17.3	17.7	20.0	23.1	22.1	843.2	157.0	30.5	28.5	14.5	
23	18.4	13.3	17.2	17.8	20.0	23.2	27.9	819.7	148.8	28.8	8.1	16.1	
24	17.6	13.2	17.1	17.9	20.0	23.3	27.3	826.5	141.0	27.1	7.7	34.9	
25	16.8	13.1	17.1	18.0	20.1	23.4	24.8	802.2	133.7	28.0	7.2	17.9	
26	16.0	13.0	17.0	18.0	20.2	23.5	23.4	737.4	126.7	27.5	6.8	16.7	
27	15.7	13.0	17.0	18.1	20.3	23.7	22.5	671.1	120.0	22.8	6.3	15.7	
28	14.4	12.9	17.0	18.2	20.4	23.8	22.0	612.3	113.7	21.5	5.9	15.5	
29	14.3	12.9	16.9	18.3		23.9	21.7	570.5	107.8	20.2	5.1	14.0	
30	13.8	12.8	16.9	18.4		24.0	21.2	527.2	102.5	39.1	4.7	13.0	
31	15.8		16.9	18.4		24.1		488.8		20.7	4.4		
SIMULATED TOTALS	562.5	442.9	560.4	541.7	548.7	693.2	708.5	15398.4	7342.7	1521.9	437.9	430.6	29189.3 CFS

TOTAL STATISTICAL SUMMARY FOR 1 WATER YRS

	MONTHLY		DAILY	
	REFFRENCE	SIMULATED	REFERENCE	SIMULATED
MEAN	2405.60	2432.44	79.09	79.97
MAXIMUM	14092.04	15398.39	919.23	1266.56
VARIANCE	18195728.00	20465536.00	25021.94	28993.11
STANDARD DEVIATION	4265.64	4523.89	158.18	170.27

	MONTHLY	DAILY
SUM OF (REFERENCE - SIMULATED)	-322.07	-322.04
ROOT SUM SQUARE	1510.44	506.55
SUM SQUARED	0.04	1.78
SUM SQUARED (IBM METHOD)	0.03	1.47
CORRELATION COEFFICIENT	0.9964	0.9896

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL	
RAIN+MELT	1.755	0.634	0.558	0.558	0.504	0.558	0.873	13.875	1.614	1.080	3.690	3.906	29.606	INCHES
SURFACE-SNOW-EVAP.	0.006	0.305	0.314	0.215	0.138	0.276	0.380	0.930	0.0	0.0	0.0	0.0	2.564	INCHES
INTSNOWLOSS	0.152	0.251	0.080	0.061	0.152	0.228	0.241	0.018	0.0	0.0	0.0	0.023	1.207	INCHES
STORAGES-UZS	0.555	0.544	0.330	0.345	0.356	0.368	0.449	1.224	0.0	0.295	0.395	0.814		IN
LZS	4.136	4.646	5.197	5.543	5.818	6.099	6.303	8.905	6.470	3.450	3.657	4.420		IN
IFS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.008	0.0	0.0	0.0	0.0		IN
GWS	0.100	0.087	0.115	0.125	0.139	0.163	0.146	3.075	0.695	0.142	0.043	0.097		IN
INDICES- UZC	0.517	0.250	0.250	0.250	0.250	0.250	0.254	1.501	3.004	2.706	1.651	1.256		
BFNX	0.424	0.255	0.230	0.220	0.231	0.262	0.250	4.131	1.738	0.678	0.282	0.226		
SIAM	0.797	0.476	0.330	0.330	0.330	0.330	0.404	0.899	1.331	1.385	1.185	1.050		
CHECK ON SNOW	20.1194		18.9126											

DAILY FLOW DURATION AND ERROR TABLE

FLOW INTERVAL	CASES	AV.ERROR	AVR. ABS. ERROR	STANDARD ERROR
0.0-	0.0			
1.0-	0.0			
1.6-	0.0			
2.7-	5.0	-0.5	0.46	0.06
4.5-	10.0	-0.5	0.55	0.14
7.4-	9.0	-0.8	0.80	0.32
12.2-	157.0	-0.4	0.37	0.49
20.1-	99.0	-0.4	0.54	0.94
33.1-	15.0	-2.6	3.07	2.31
54.6-	10.0	-4.7	7.41	6.44
90.0-	11.0	-8.0	12.25	10.55
148.4-	13.0	-3.6	21.83	23.89
244.7-	10.0	-21.9	28.98	20.32
403.4-	17.0	-3.8	42.85	48.80
665.1-	9.0	103.7	106.40	113.56
1096.6-	0.0			
1808.0-	0.0			
2981.0-	0.0			
4914.8-	0.0			
8103.1-	0.0			
13359.7-	0.0			
22026.5-	0.0			
	365.0	0.9	7.24	227.83

CORRELATION COEFFICIENT (DAILY) 0.9896

TWENTY HIGHEST CLOCKHOUR RAINFALL EVENTS IN THE WATER YEAR
0.500 0.495 0.400 0.400 0.380 0.274 0.265 0.261 0.240 0.200 0.200 0.200 0.170 0.162 0.150 0.150 0.150 0.149 0.143 0.140

TWENTY HIGHEST CLOCKHOUR OVERLAND FLOW RUNOFF EVE NTS IN THE WATER YEAR
0.010 0.006 0.005 0.005 0.005 0.005 0.004 0.004 0.002 0.002 0.002 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001 0.001

DAILY SOIL MOISTURE

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1	3.9	4.2	4.8	5.2	5.6	5.8	6.1	6.3	8.9	6.3	3.5	3.7
2	3.9	4.2	4.8	5.2	5.6	5.8	6.1	6.3	8.9	6.2	3.5	3.7
3	3.9	4.3	4.8	5.2	5.6	5.8	6.1	6.4	8.9	6.0	3.5	3.7
4	3.9	4.3	4.9	5.2	5.6	5.9	6.1	6.5	8.9	5.9	3.5	3.7
5	3.8	4.3	4.9	5.3	5.6	5.9	6.1	6.6	8.9	5.8	3.5	3.7
6	3.7	4.3	4.9	5.3	5.6	5.9	6.2	6.8	8.9	5.6	3.5	3.7
7	3.7	4.3	4.9	5.3	5.6	5.9	6.2	7.0	8.9	5.6	3.5	3.7
8	3.7	4.4	4.9	5.3	5.6	5.9	6.2	7.1	8.9	5.6	3.5	3.7
9	3.6	4.4	4.9	5.3	5.6	5.9	6.2	7.1	8.9	5.4	3.5	3.7
10	3.6	4.4	4.9	5.3	5.6	5.9	6.2	7.2	8.9	5.3	3.5	3.6
11	3.6	4.4	5.0	5.3	5.7	5.9	6.2	7.5	8.9	5.2	3.5	3.6
12	3.6	4.4	5.0	5.3	5.7	5.9	6.2	7.6	8.9	5.0	3.5	3.7
13	3.6	4.4	5.0	5.3	5.7	5.9	6.2	7.6	8.9	4.9	3.5	3.7
14	3.6	4.4	5.0	5.4	5.7	5.9	6.2	7.6	8.9	4.8	3.5	4.0
15	3.6	4.4	5.0	5.4	5.7	6.0	6.2	7.7	8.9	4.7	3.5	4.0
16	3.6	4.5	5.0	5.4	5.7	6.0	6.2	7.8	8.7	4.6	3.5	4.1
17	3.6	4.5	5.0	5.4	5.7	6.0	6.2	7.9	8.5	4.4	3.5	4.1
18	3.6	4.5	5.0	5.4	5.7	6.0	6.2	8.0	8.4	4.4	3.5	4.1
19	3.7	4.5	5.1	5.4	5.7	6.0	6.2	8.2	8.2	4.4	3.6	4.2
20	3.8	4.5	5.1	5.4	5.7	6.0	6.2	8.3	8.1	4.2	3.6	4.3
21	3.9	4.5	5.1	5.4	5.8	6.0	6.2	8.5	7.9	4.1	3.6	4.3
22	4.0	4.5	5.1	5.4	5.8	6.0	6.3	8.6	7.7	4.0	3.7	4.3
23	4.0	4.6	5.1	5.5	5.8	6.0	6.3	8.7	7.6	3.9	3.7	4.3
24	4.0	4.6	5.1	5.5	5.8	6.0	6.3	8.8	7.4	3.8	3.7	4.4
25	4.0	4.6	5.1	5.5	5.8	6.0	6.3	8.8	7.2	3.7	3.7	4.4
26	4.1	4.6	5.1	5.5	5.8	6.1	6.3	8.9	7.1	3.7	3.7	4.4
27	4.1	4.6	5.1	5.5	5.8	6.1	6.3	8.9	6.9	3.6	3.7	4.4
28	4.1	4.6	5.2	5.5	5.8	6.1	6.3	8.9	6.8	3.5	3.7	4.4
29	4.1	4.6	5.2	5.5		6.1	6.3	8.9	6.6	3.4	3.7	4.4
30	4.1	4.6	5.2	5.5		6.1	6.3	8.9	6.5	3.5	3.7	4.4
31	4.1		5.2	5.5		6.1		8.9		3.5	3.7	

MULTI= 0 CONOPT(10)= 0 CONOPT(15)= 3 IBFLAG= 0 KWMAIN= 2

MULTI= 0 CONOPT(10)= 0 CONOPT(15)= 3 IBFLAG= 10 KWMAIN= 6

IDFLAG= 0 IENDFG= 0 ISFLAG= 10 MAIN= 3

IDFLAG= 0 IENDFG= 1 ISFLAG= 10 MAIN= 23

*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 10/18/57 STUDY SNOW62

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	55.8	56.0	0.20	0.4	
ANNUAL PEAK(CFS)		1391.2			0.0
PEAK(HR)	71	71	0	0.0	
RUNOFF(IN)	0.0328	0.0329	0.0002		0.5

*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 4/21/58 STUDY SNOW62

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	39.8	41.1	2.20	5.5	
ANNUAL PEAK(CFS)		1391.2			0.2
PEAK(HR)	47	47	0	0.0	
RUNOFF(IN)	0.0393	0.0415	0.0022		5.6

*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 5/10/58 STUDY SNOW62

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	1041.5	1389.4	348.50	33.5	
ANNUAL PEAK(CFS)		1391.2			25.0
PEAK(HR)	51	53	2	3.9	
RUNOFF(IN)	0.9162	1.1698	0.2536		27.7

*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 8/3/58 STUDY SNOW62

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	107.8	106.1	-0.80	0.7	
ANNUAL PEAK(CFS)		1391.2			0.1
PEAK(HR)	71	71	0	0.0	
RUNOFF(IN)	0.0432	0.0404	0.0029	6.6	

*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 9/22/58 STUDY SNOW62

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	52.3	51.3	-0.30	0.6	
ANNUAL PEAK(CFS)		1391.2			0.0
PEAK(HR)	59	59	0	0.0	
RUNOFF(IN)	0.0368	0.0346	0.0022	6.1	

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62

TOTAL DAILY STREAMFLOW STATISTICAL SUMMARY FOR 1 WATER YRS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF O-S	ROOT SUM SQUARE	CORR COEFF
REFERENCE WY 58	79	919	25021	158			
SIMULATED	79	1266	28993	170	-322	506	0.9896

MODEL	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
PARAMETERS	6.0	10.0	1.50	1.00	0.30	0.42	0.15	0.91	0.94	0.95	0.350	6	31.46	*****	107.0	670.0	2.90	0.60

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62

TOTAL MONTHLY STREAMFLOW STATISTICAL SUMMARY FOR 1 WATER YRS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF O-S	ROOT SUM SQUARE	DRIEST MONTH ** (CFS)	CORR COEFF
REFERENCE WY 58	2405	14092	18195728	4265			454 (2)	
SIMULATED	2432	15398	20465536	4523	-322	1510	430 (12)	0.9964

MODEL	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
PARAMETERS	6.0	10.0	1.50	1.00	0.30	0.42	0.15	0.91	0.94	0.95	0.350	6	31.46	*****	107.0	670.0	2.90	0.60

**- THE MONTHS OF A GIVEN WATER YEAR ARE NUMBERED AS FOLLOWS:

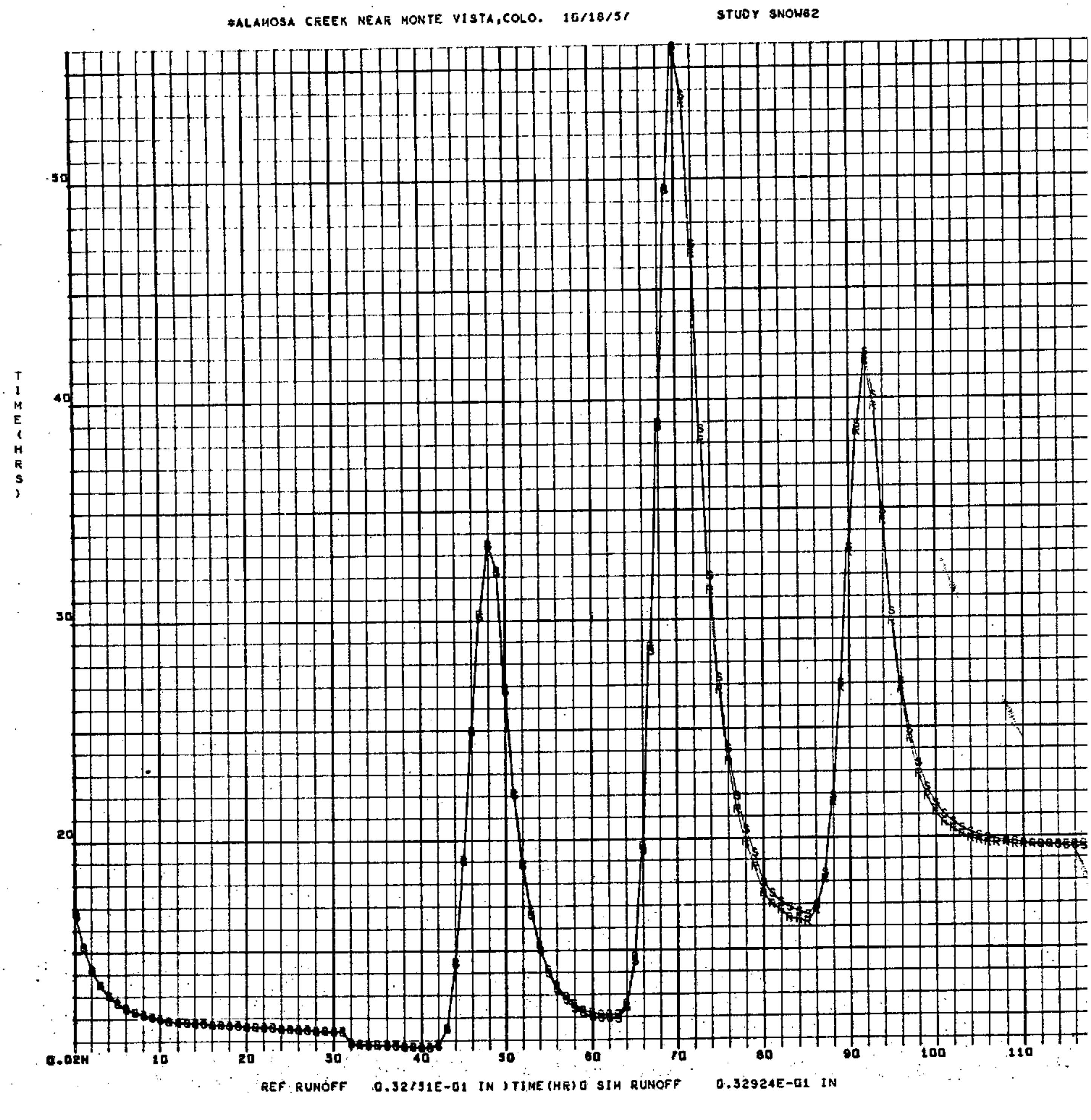
NO	1	2	3	4	5	6	7	8	9	10	11	12
MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62

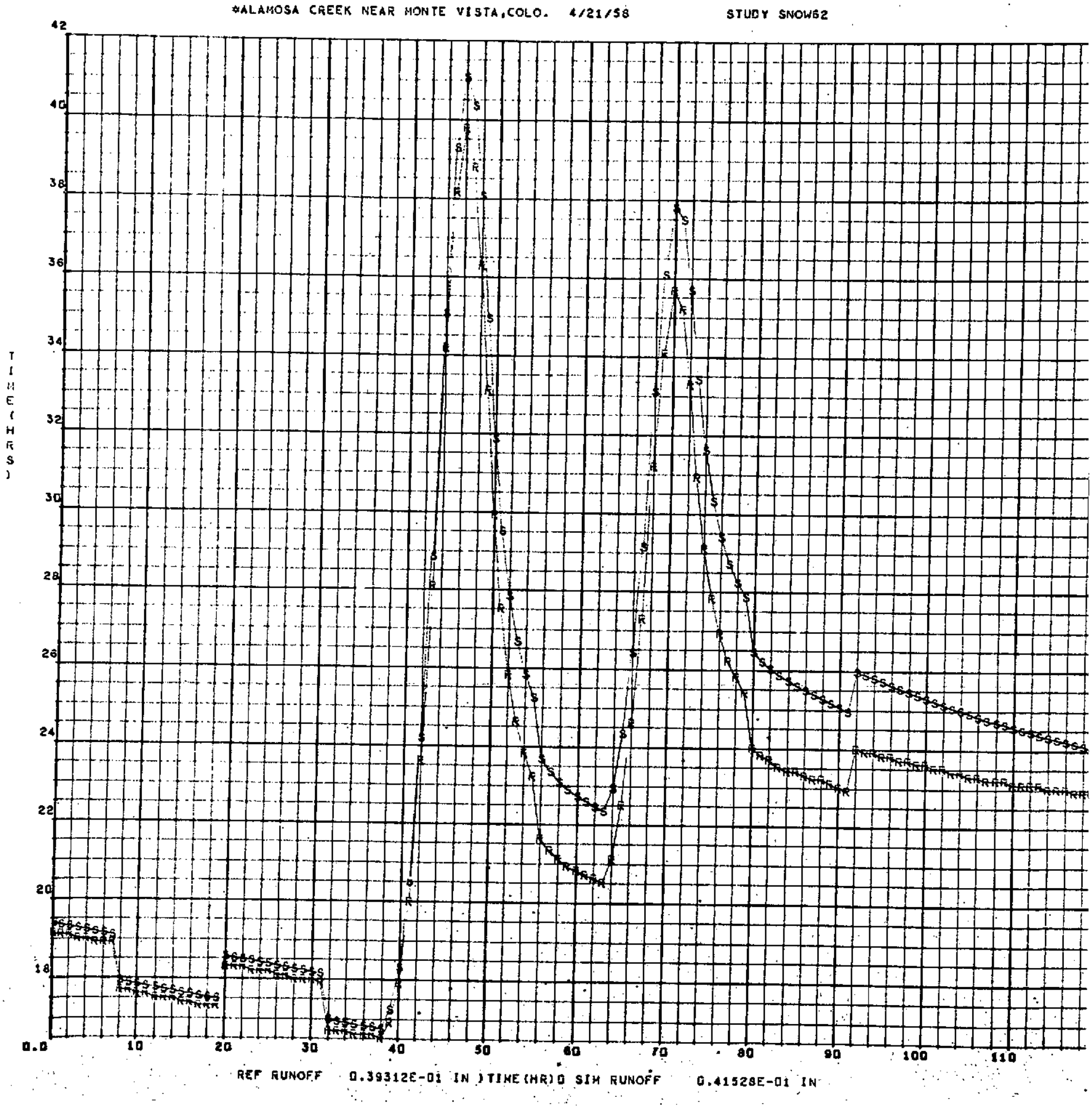
TOTAL STORM ANALYSIS SUMMARY FOR 1 WATER YRS

	PEAK (CFS)	PEAK (HR)	R/O (IN)	PEAK (CFS)	PEAK (HR)	R/O (IN)	PEAK (CFS)	PEAK (HR)	R/O (IN)	PEAK (CFS)	PEAK (HR)	R/O (IN)	PEAK (CFS)	PEAK (HR)	R/O (IN)	PEAK (CFS)	PEAK (HR)	R/O (IN)
	10/18/57			4/21/58			5/10/58			8/3/58			9/22/58					
REFERENCE WY 58	55	71	0.0328	39	47	0.0393	1041	51	0.9162	107	71	0.0432	52	59	0.0368			
SIMULATED	55	71	0.0329	41	47	0.0415	1389	53	1.1698	106	71	0.0404	51	59	0.0346			

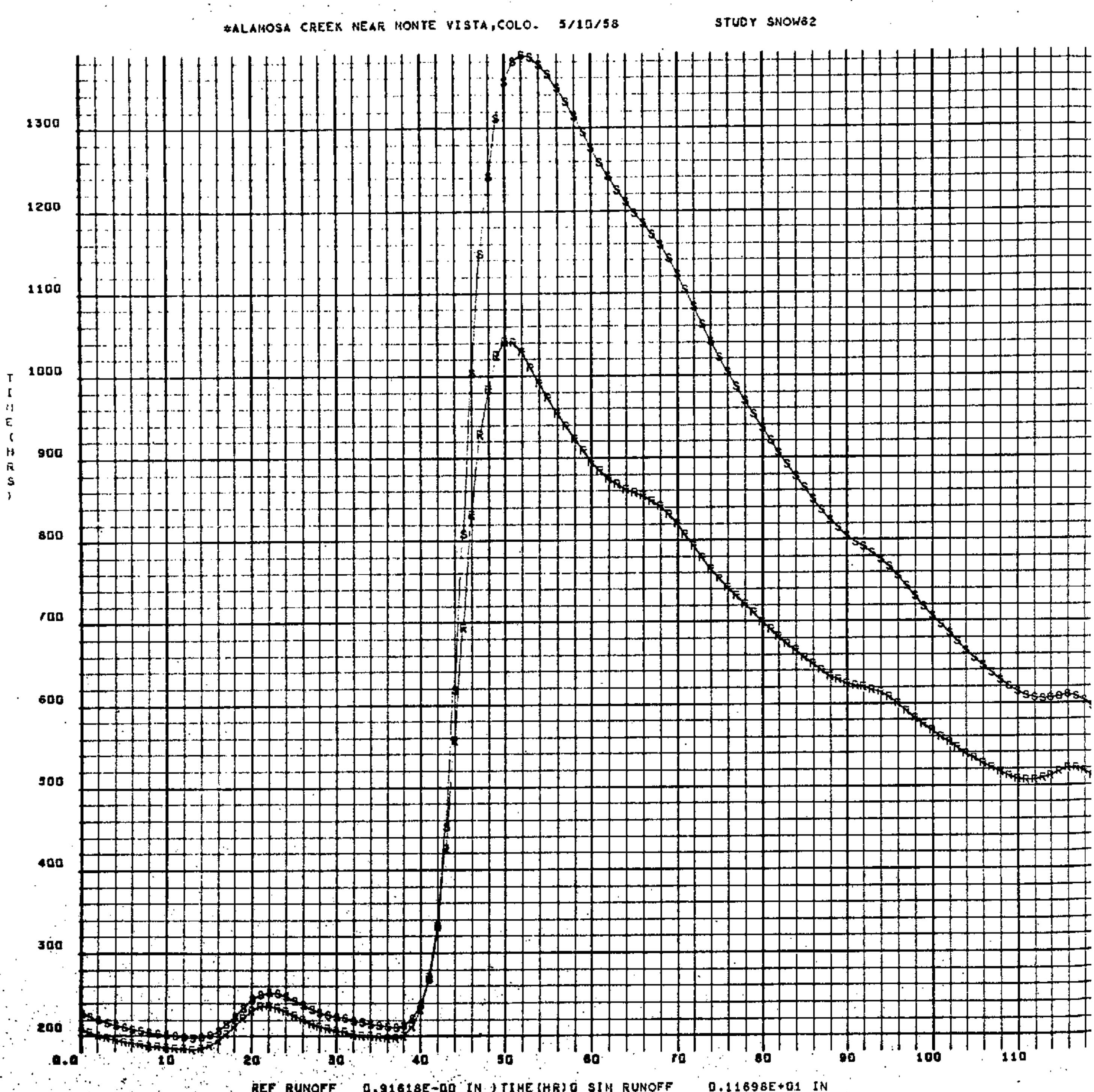
MODEL	LZC	BMIR	SUZC	BUZC	ETLF	SIAC	VINTMR	CSRX	FSRX	BFRC	OFMN	NCTRI	EPAET	MNRD	AREA	CHCAP	BIVF	IFRC
PARAMETERS	6.0	10.0	1.50	1.00	0.30	0.42	0.15	0.91	0.94	0.95	0.350	6	31.46	*****	107.0	670.0	2.90	0.60



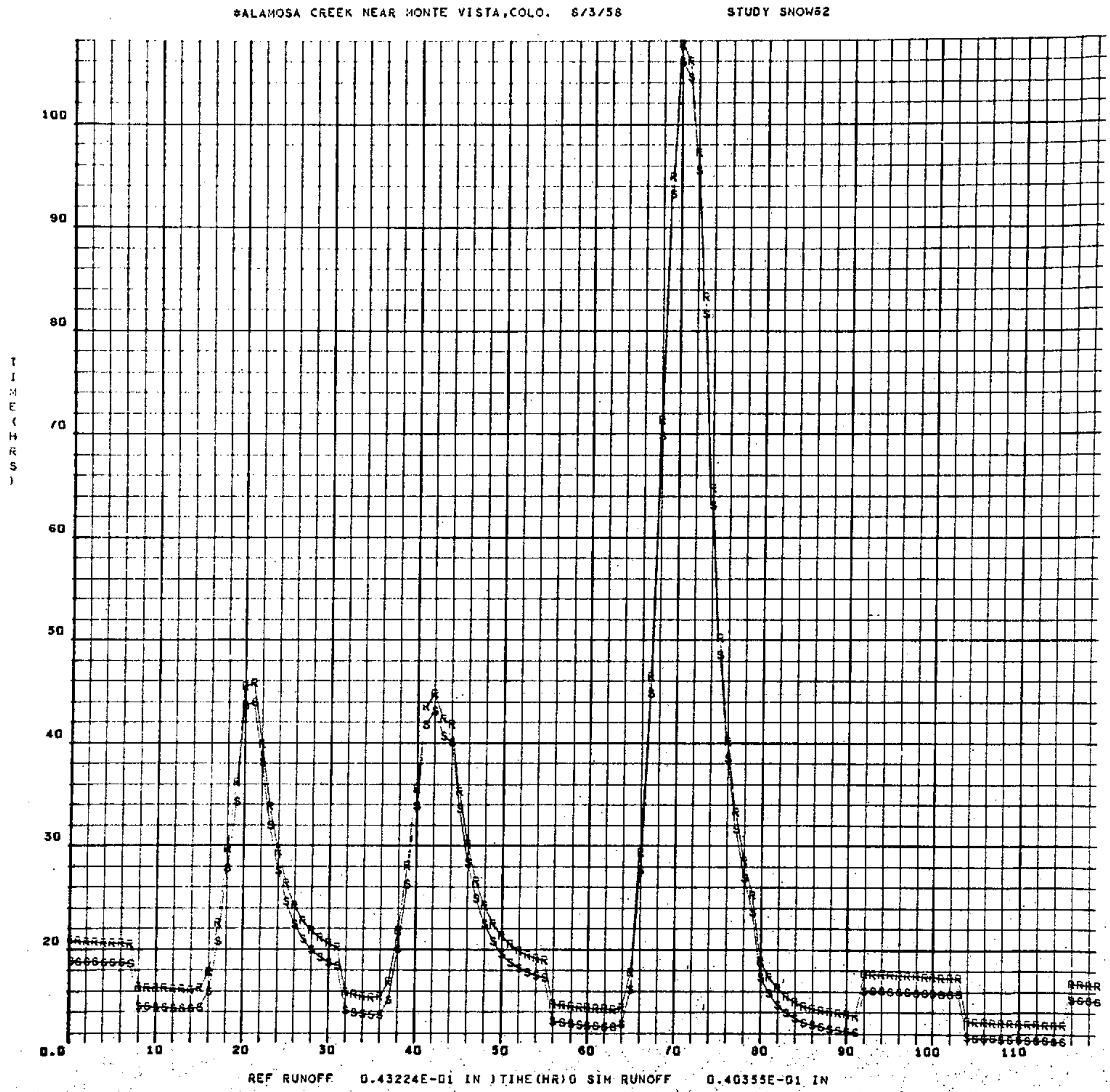
*ALAHOSA CREEK NEAR MONTE VISTA,COLO. 10/18/57
STUDY SNOW62
T I M E (H R S)
50
40
30
20
0.02H
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.32751E-01 IN)TIME(HR)D SIM RUNOFF 0.32924E-01 IN



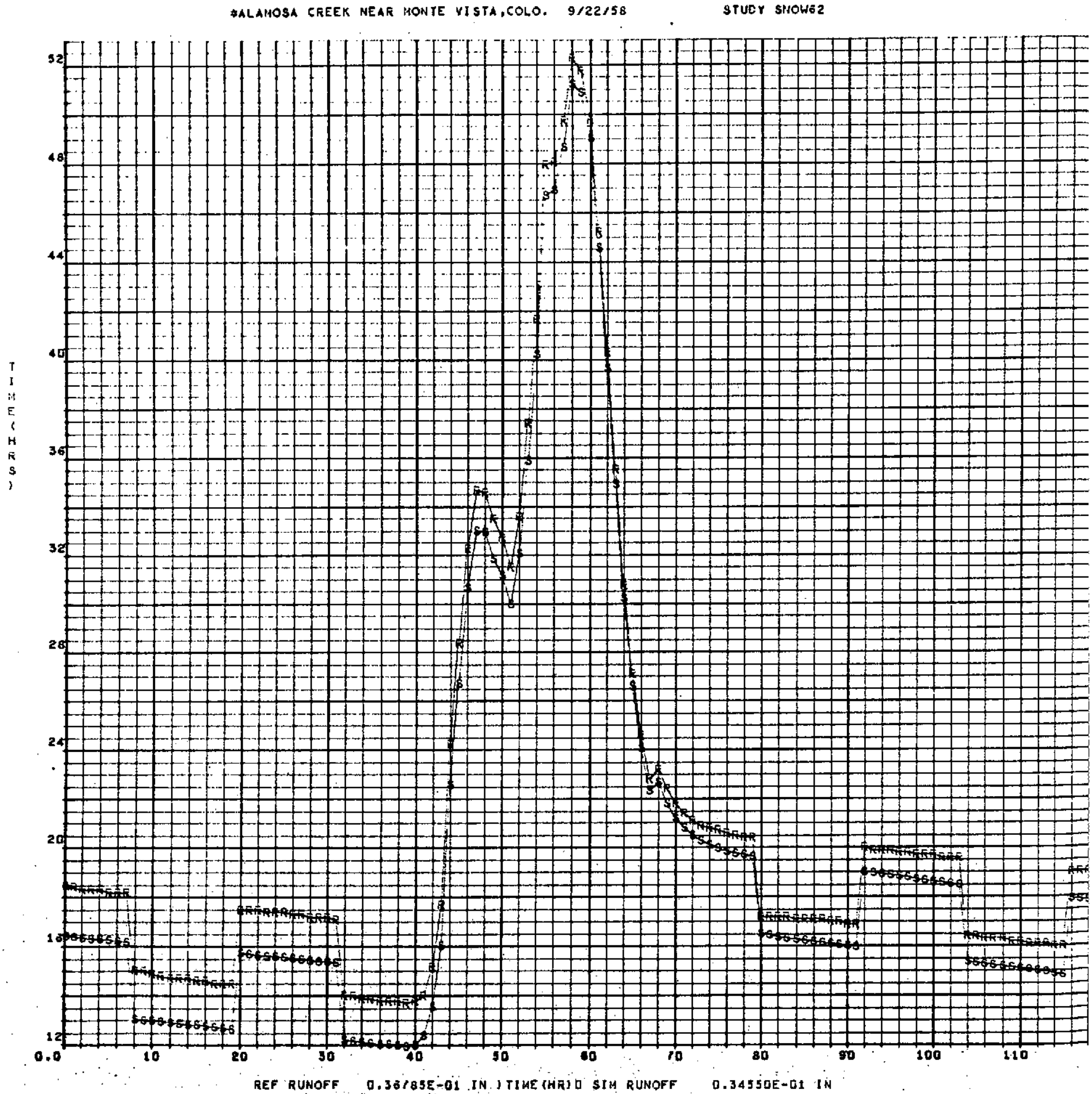
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 4/21/58
STUDY SNOW62
TIME (HRS)
REF RUNOFF 0.39312E-01 IN)TIME(HR)0 SIM RUNOFF 0.41528E-01 IN



*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 5/10/58
STUDY SNOW82
TIME(HRS)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
0.0
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.91618E-00 IN)TIME(HR)0 SIM RUNOFF 0.11698E+01 IN

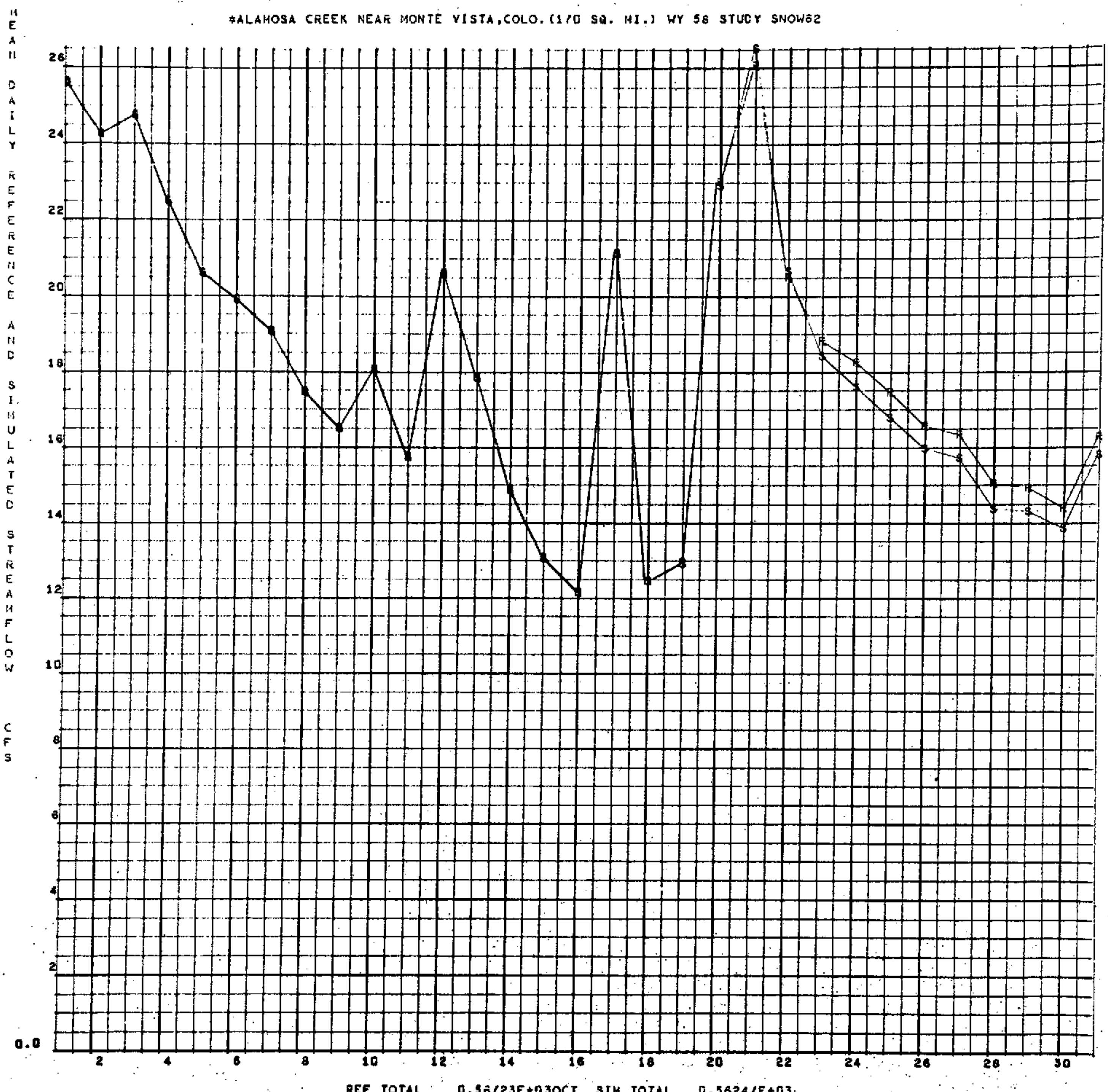


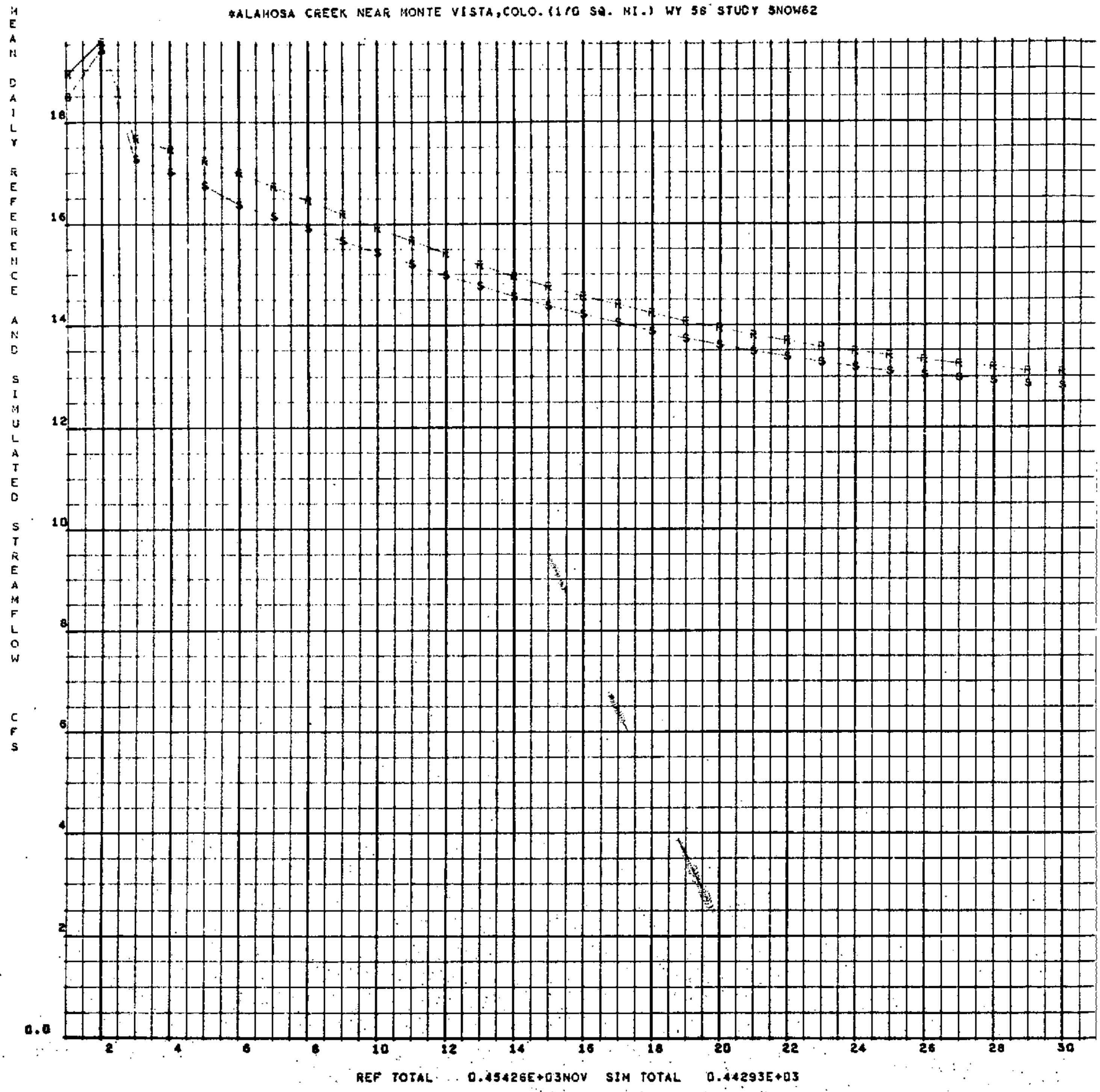
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 8/3/58
STUDY SNOW52
T I M E (H R S)
100
90
80
70
60
50
40
30
20
0.0
10
20
30
40
50
60
70
80
90
100
110
REF RUNOFF 0.43224E-01 IN)TIME(HR)O SIM RUNOFF 0.40355E-01 IN



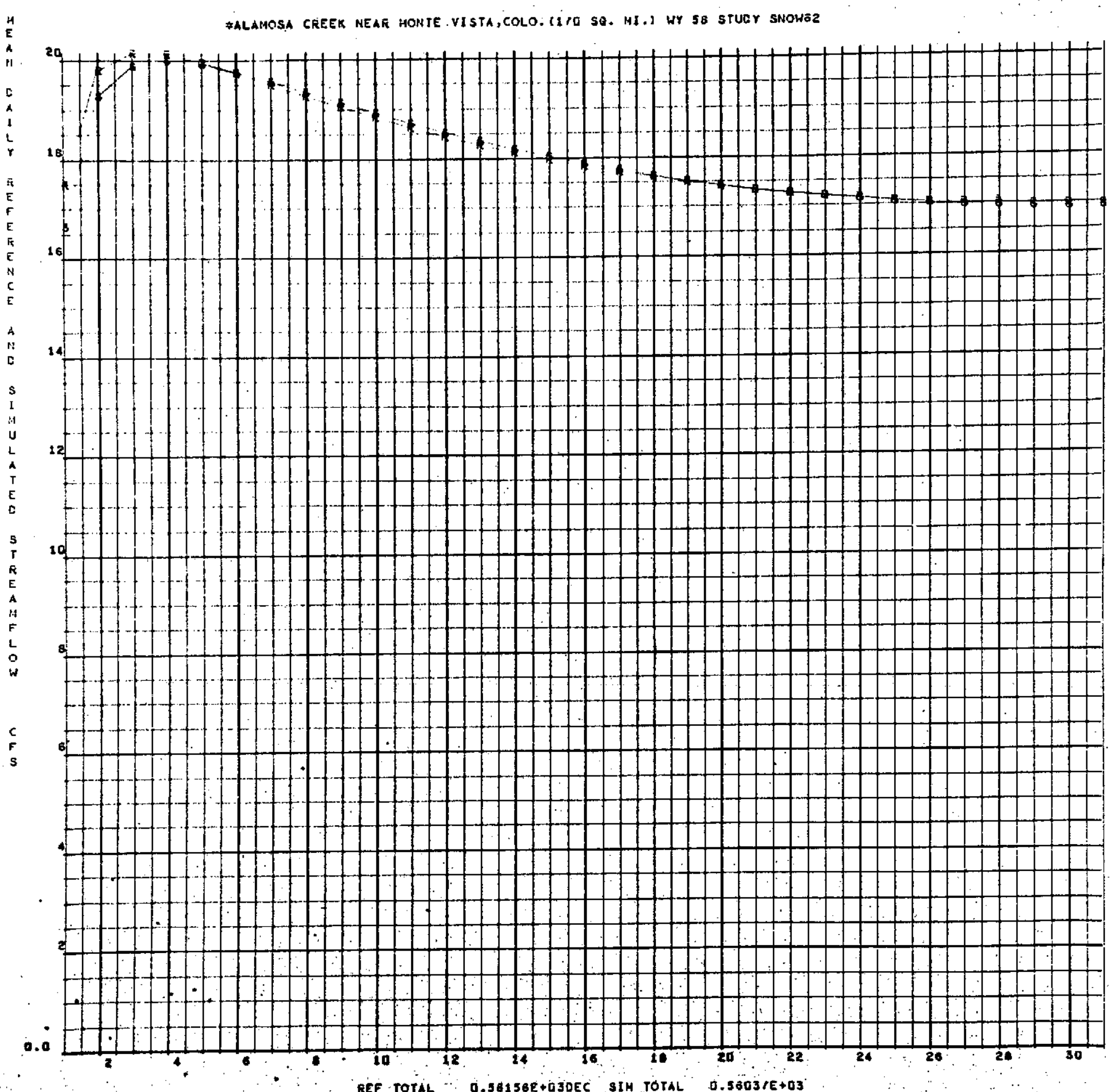
*ALAMOSA CREEK NEAR MONTE VISTA,COLO. 9/22/58
STUDY SNOW62
TIME(HRS)
REF RUNOFF 0.36785E-01 IN.)TIME(HR)0 SIM RUNOFF 0.34550E-01 IN

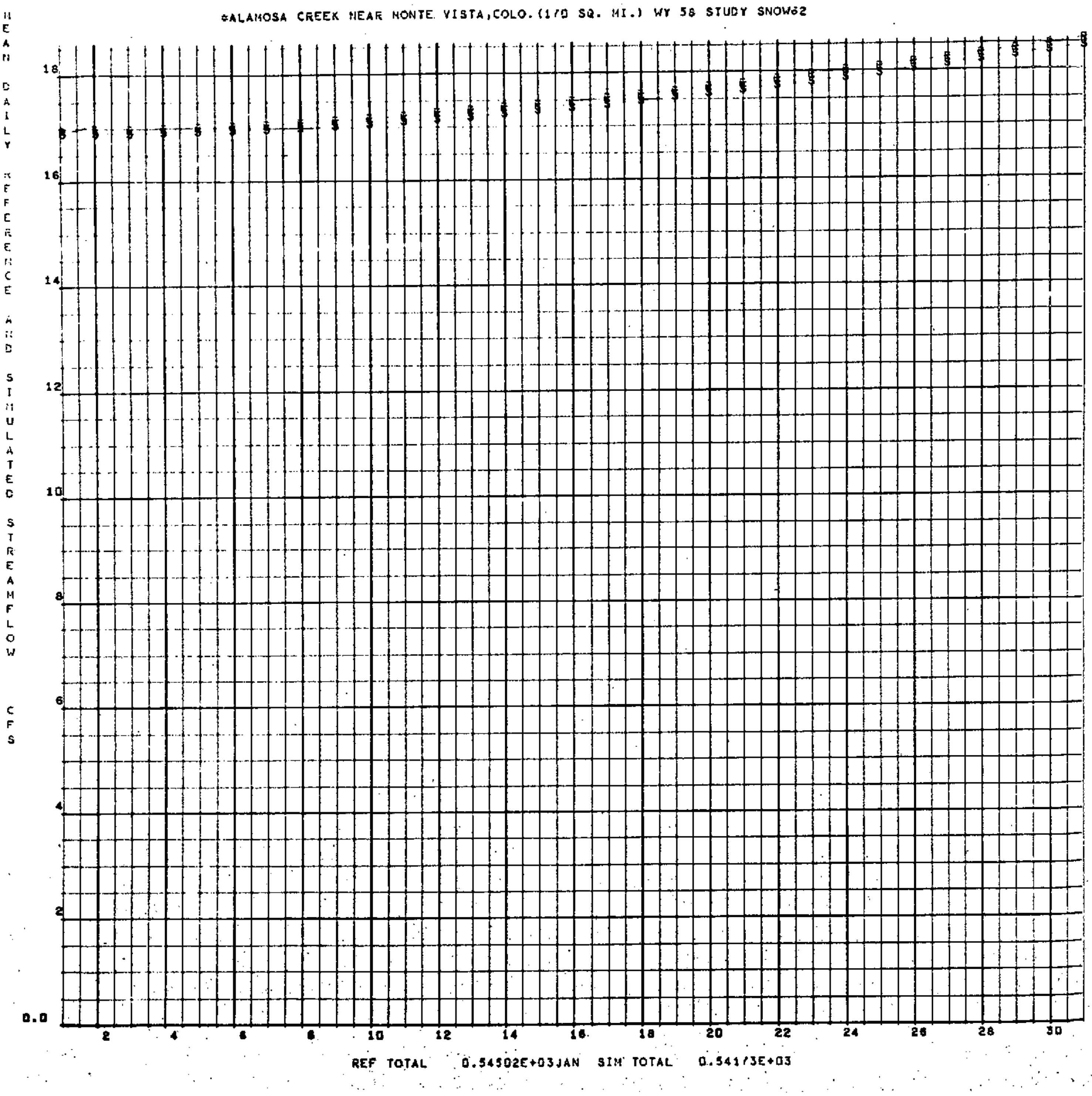
*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62



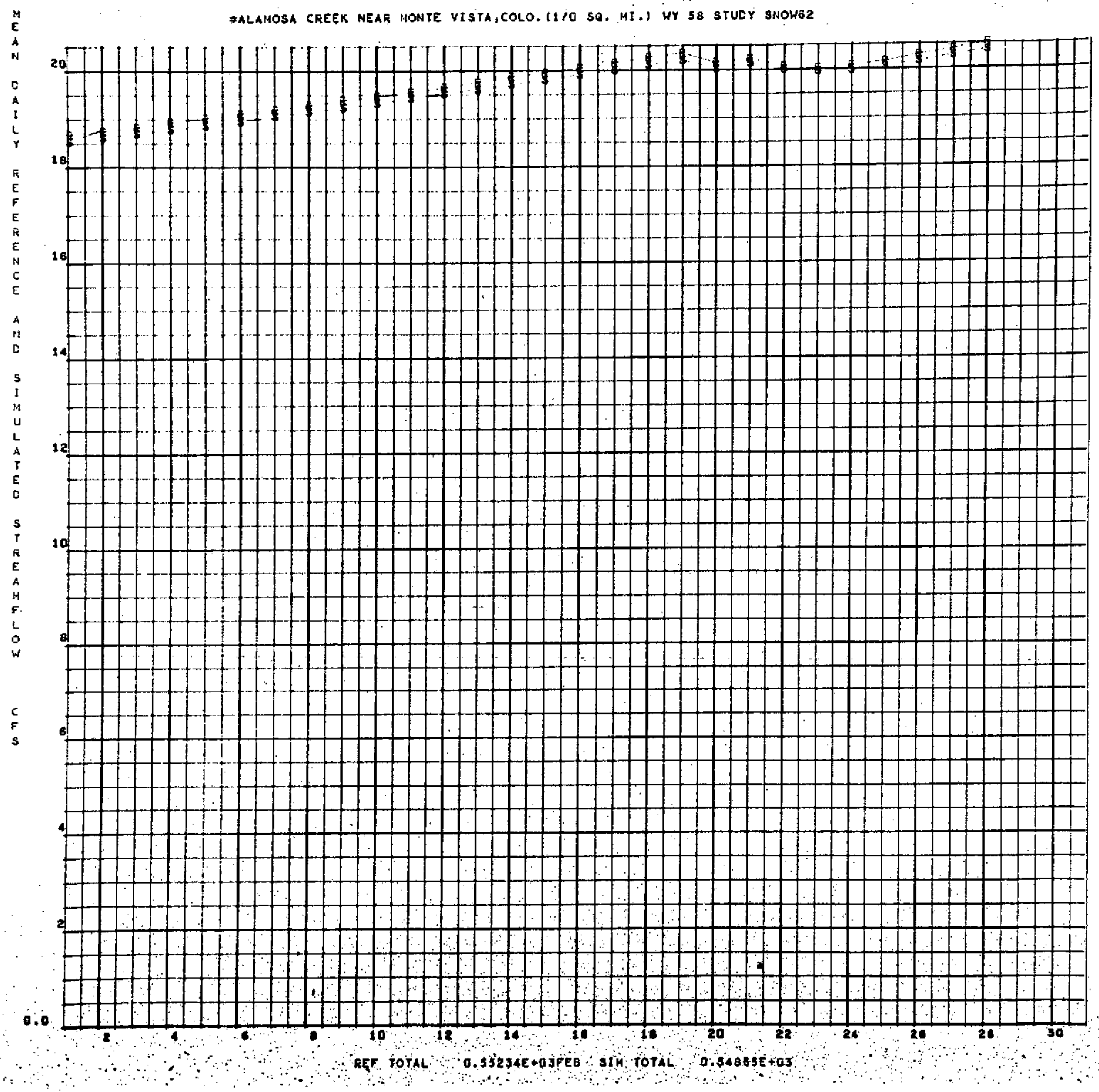


*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 56 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.45426E+03NOV SIM TOTAL 0.44293E+03

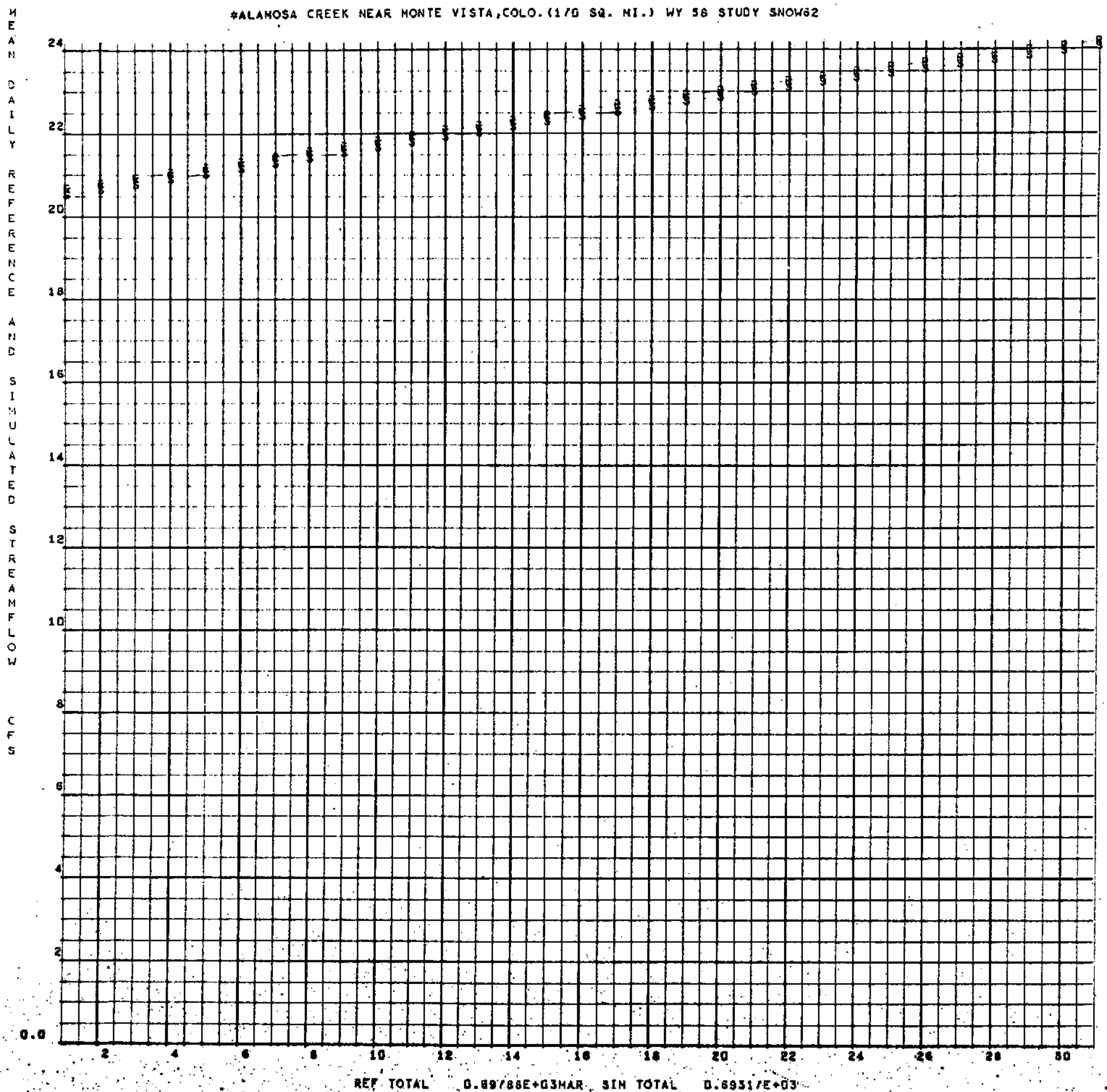

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
REF TOTAL 0.56156E+03DEC SIM TOTAL 0.56037E+03



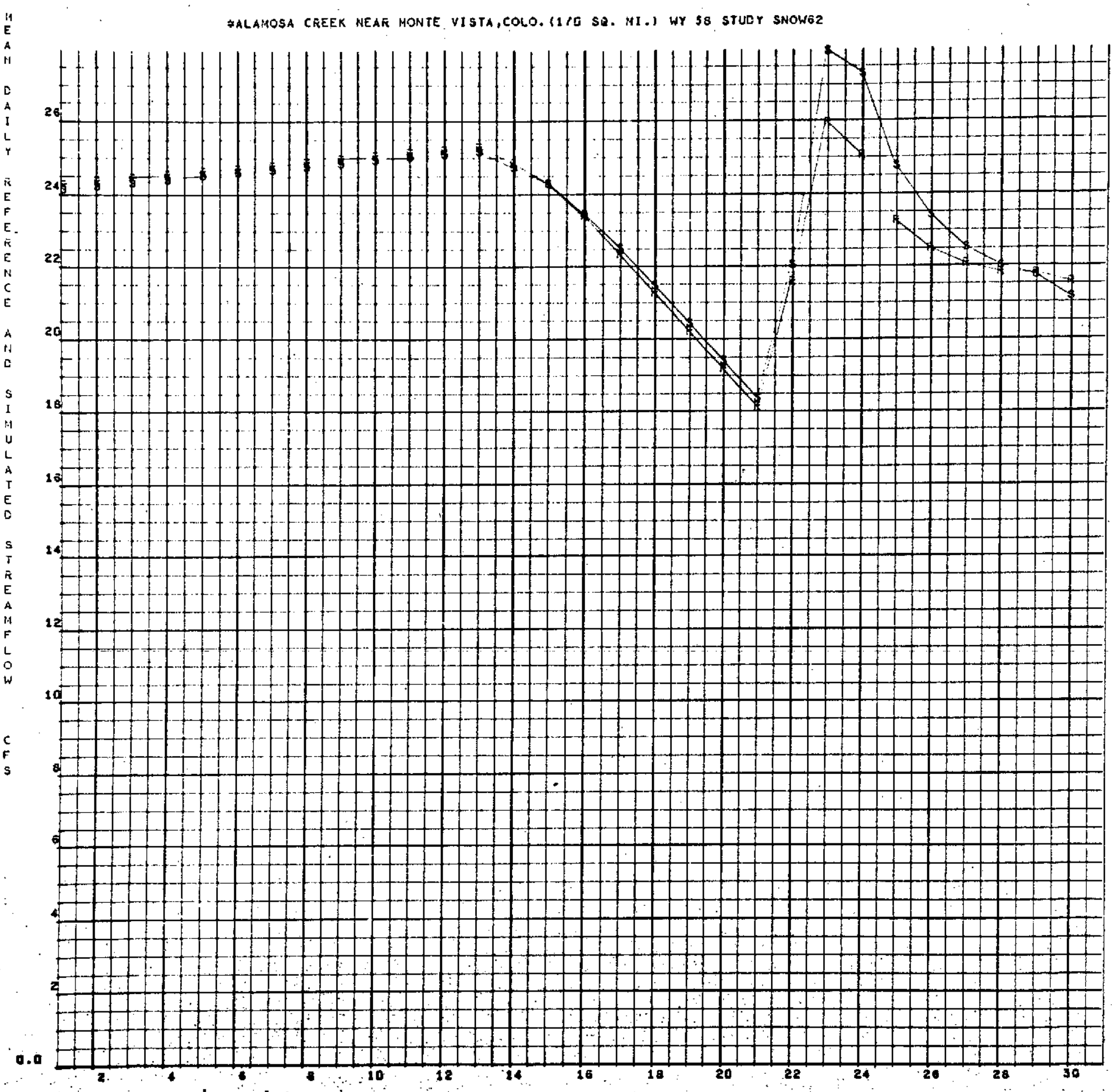
*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
18
16
14
12
10
8
6
4
2
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.54502E+03JAN SIM TOTAL 0.54173E+03



*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.55234E+03FEB SIM TOTAL 0.54865E+03

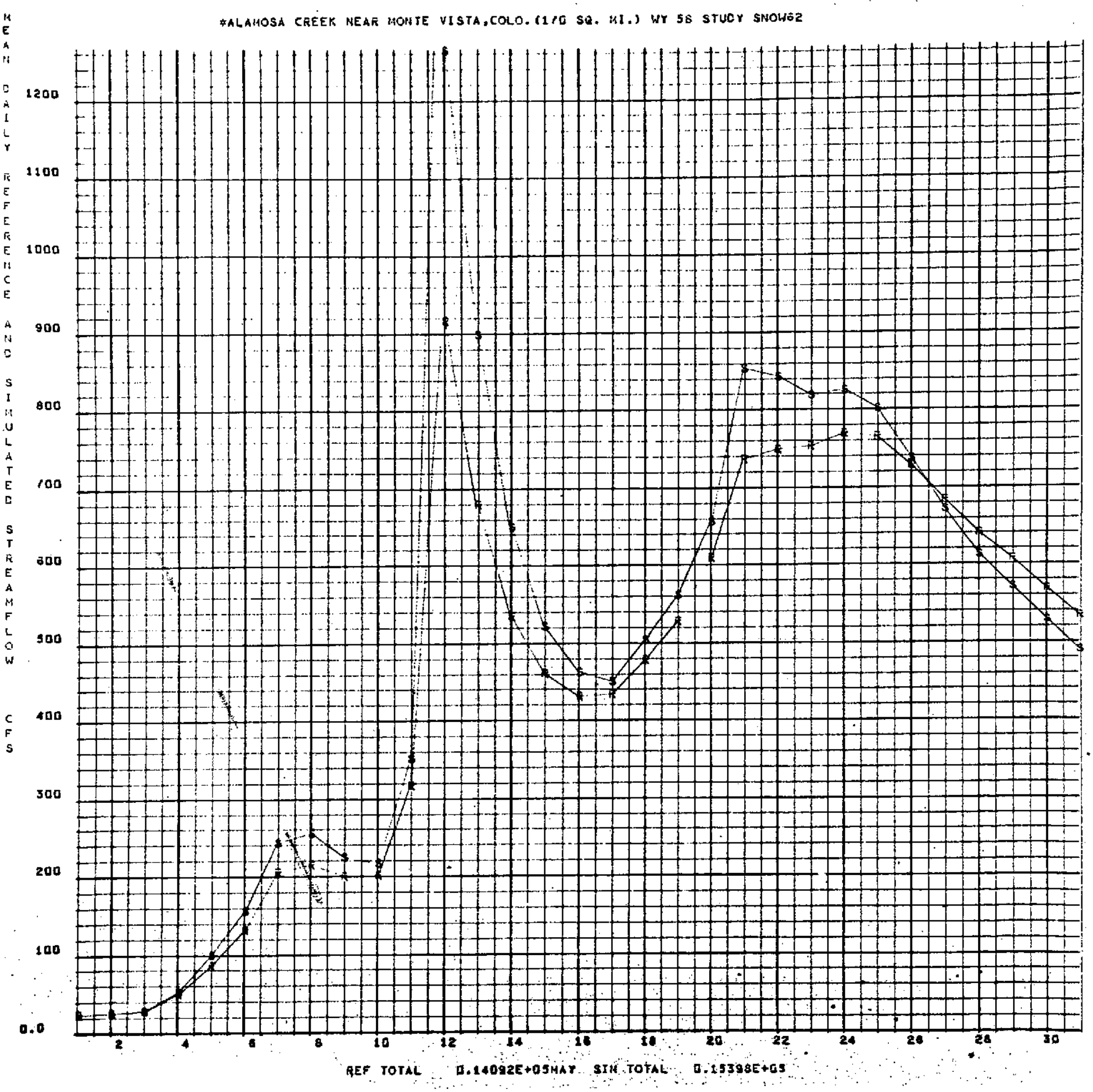

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
24
22
20
18
16
14
12
10
8
6
4
2
0.0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
REF TOTAL 0.69788E+03MAR SIM TOTAL 0.69317E+03

*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62

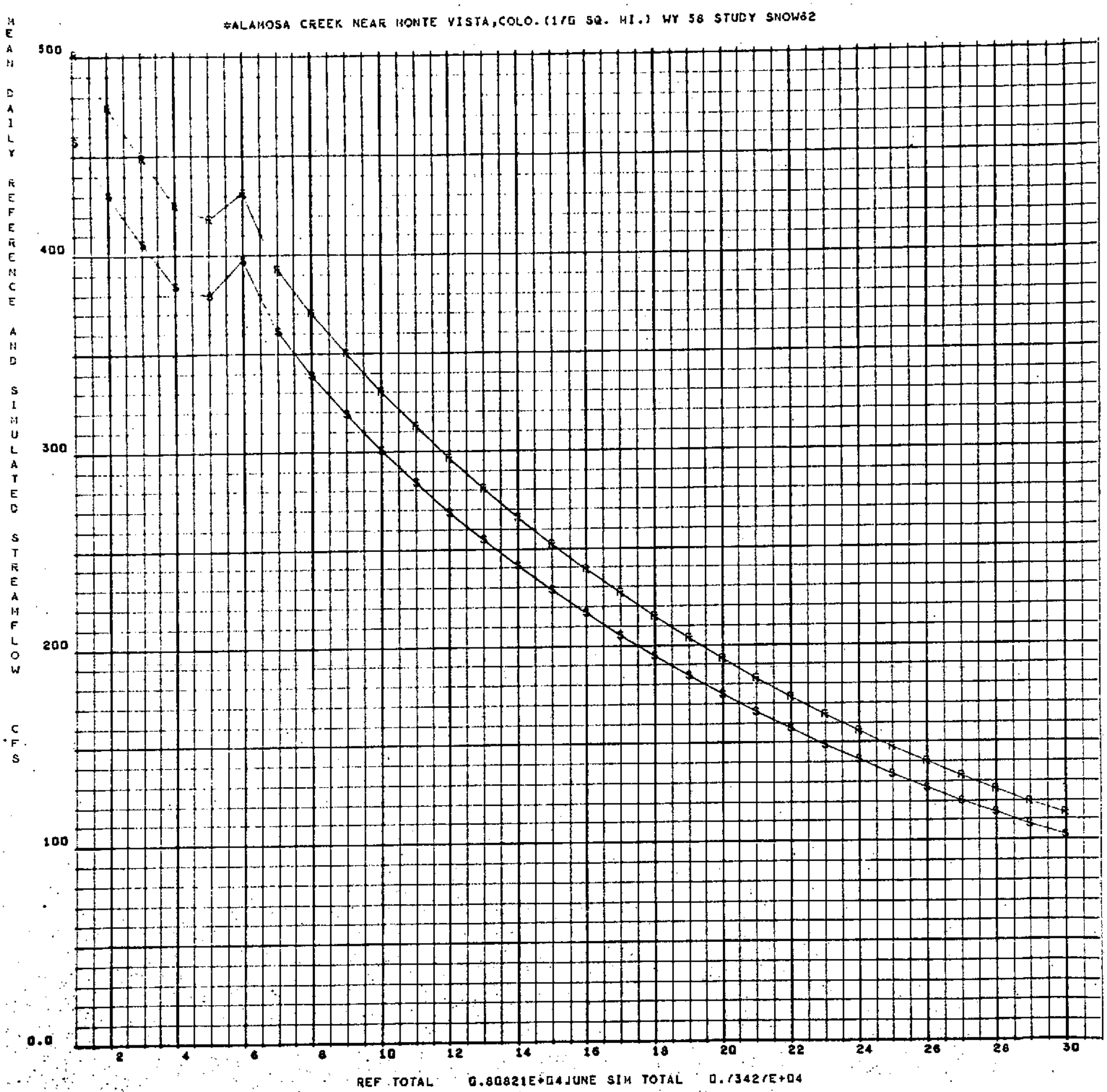


REF TOTAL 0.70180E+03APR SIM TOTAL 0.70849E+03

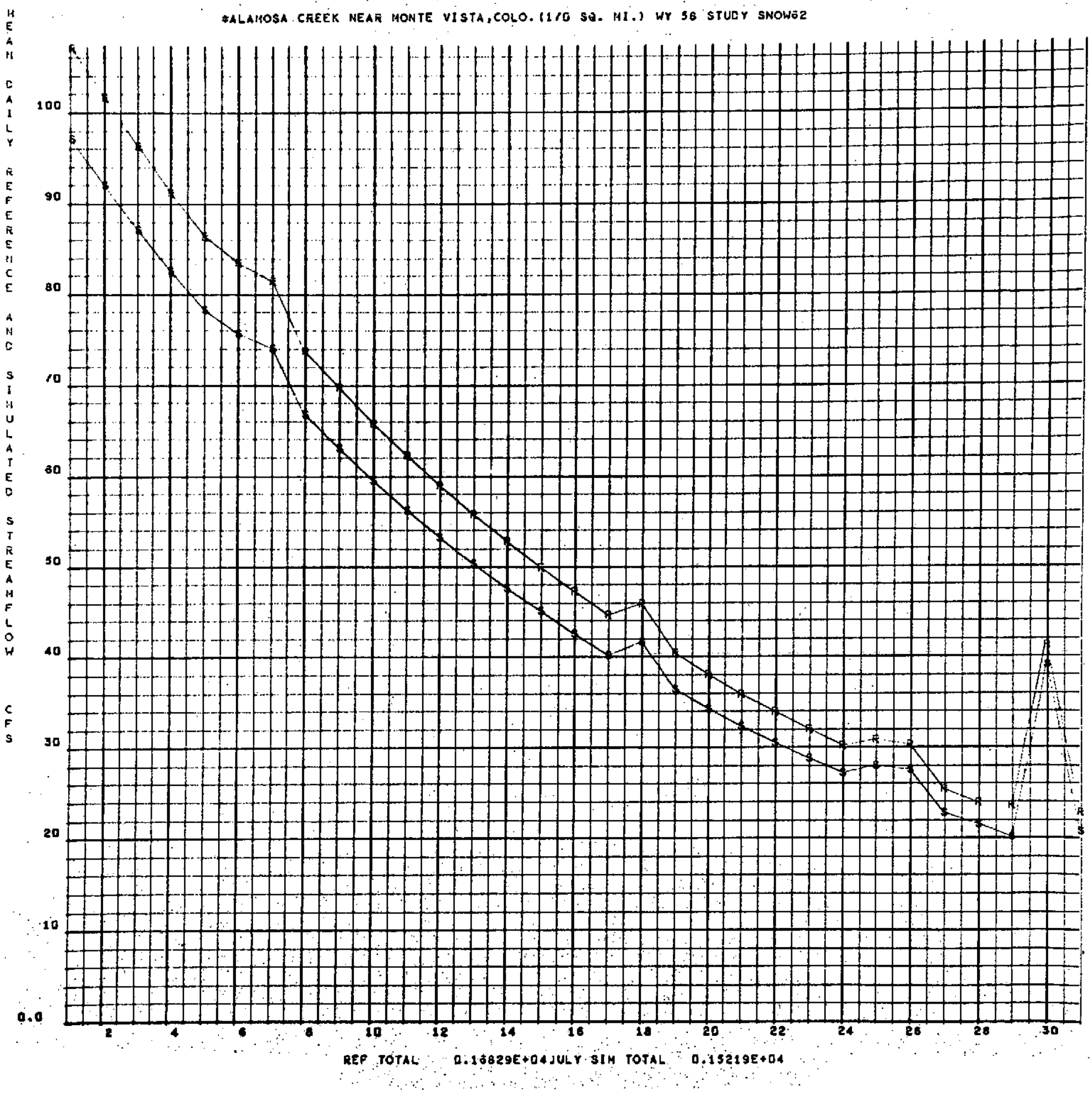
PRECEDING PAGE BLANK NOT FILMED



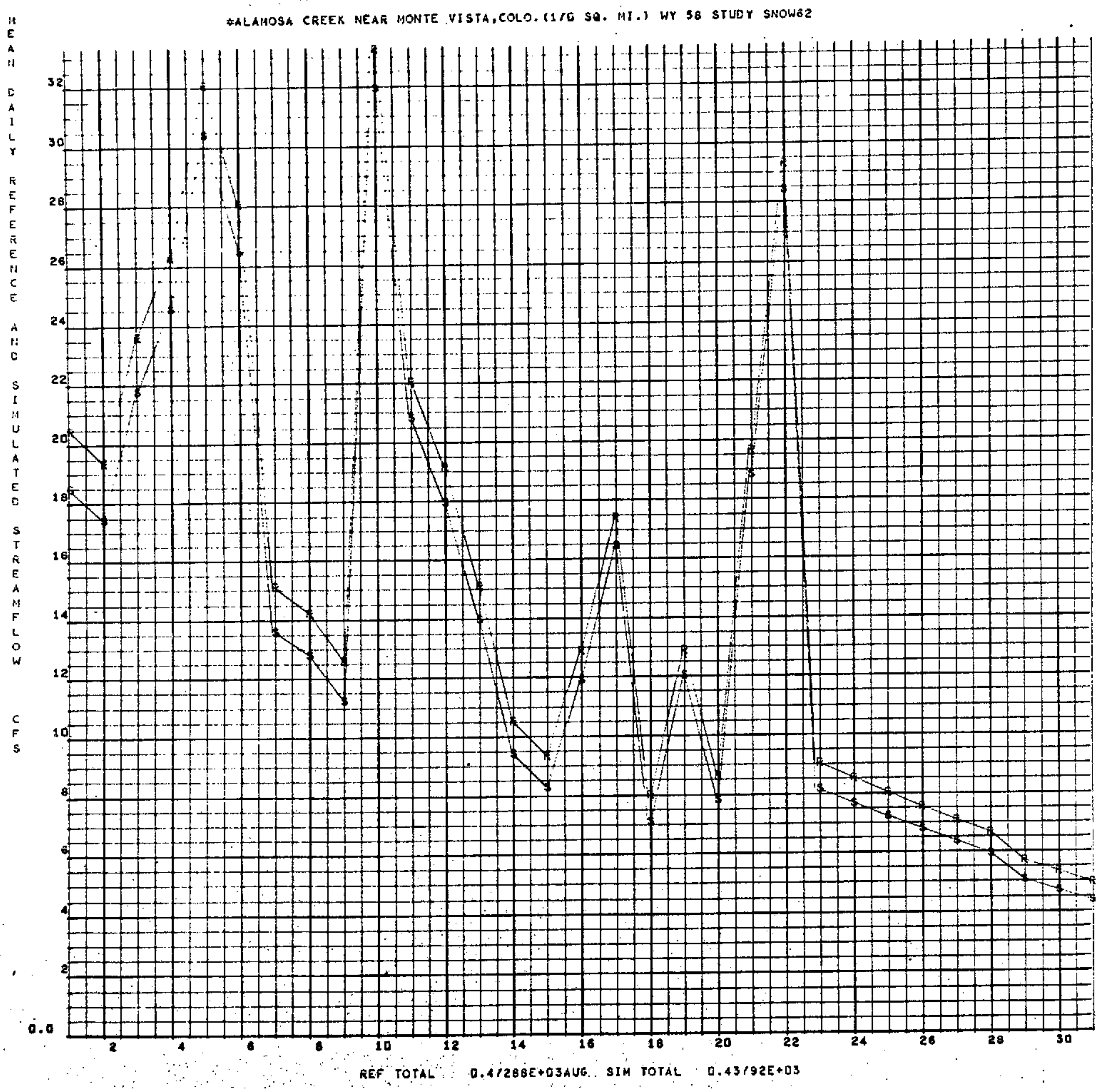
PRECEDING PAGE BLANK NOT FILMED



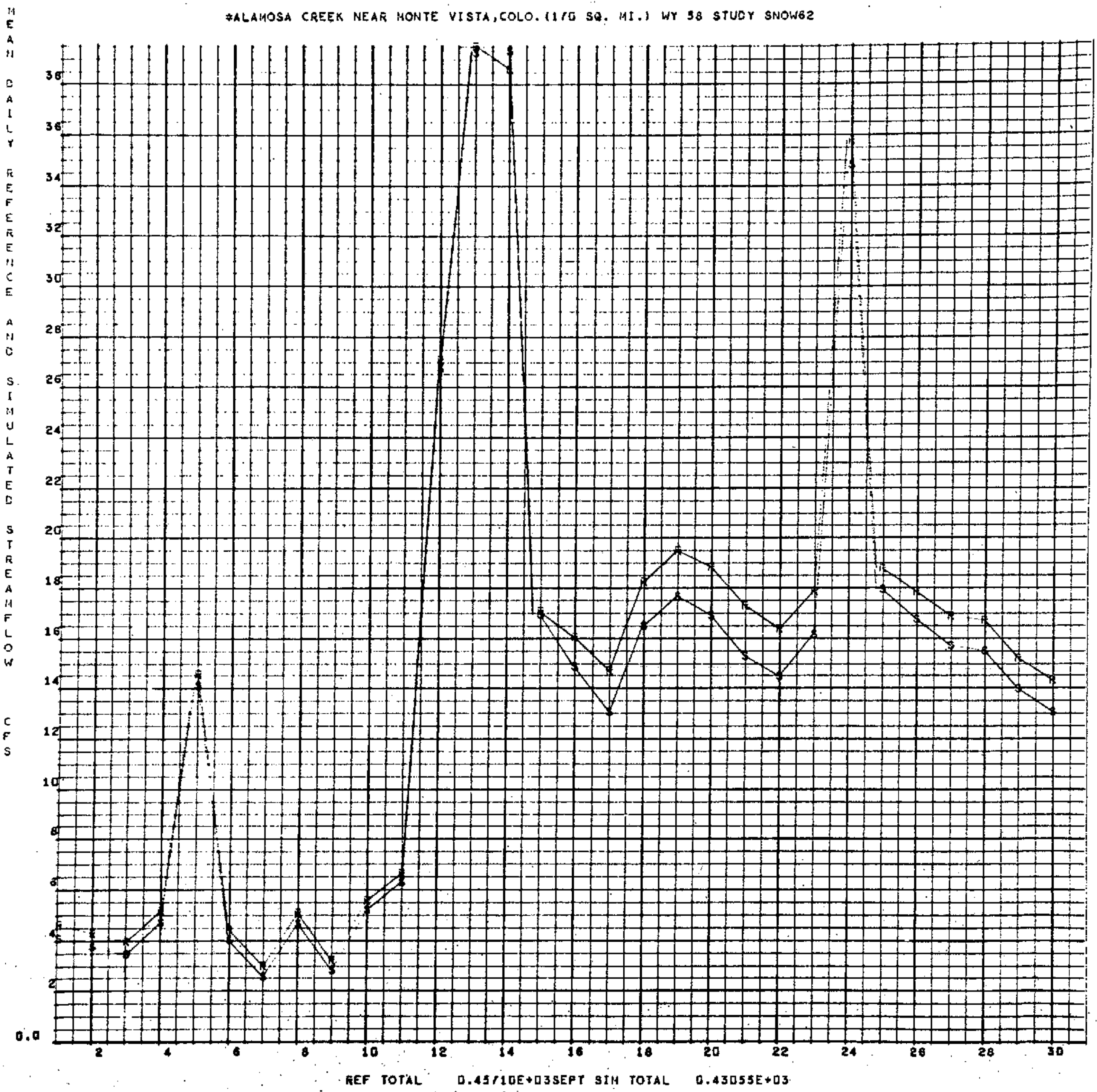
PRECEDING PAGE BLANK NOT FILMED



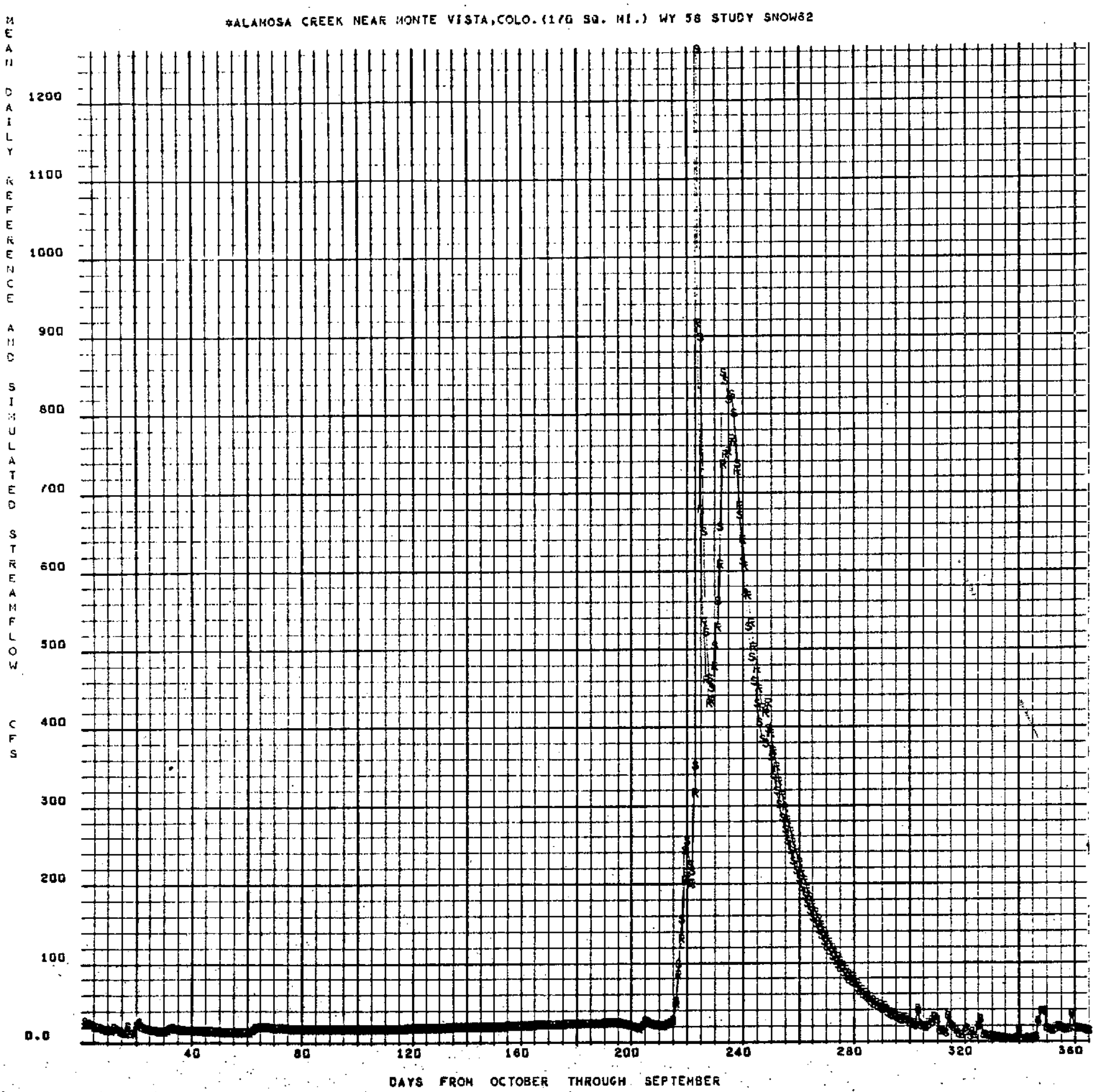
*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 56 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
100
90
80
70
60
50
40
30
20
10
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.16829E+04JULY SIM TOTAL 0.15219E+04



*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
REF TOTAL 0.47288E+03AUG. SIM TOTAL 0.43792E+03



*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW62
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
REF TOTAL 0.45710E+03SEPT SIM TOTAL 0.43055E+03


*ALAMOSA CREEK NEAR MONTE VISTA,COLO.(170 SQ. MI.) WY 58 STUDY SNOW82
MEAN DAILY REFERENCE AND SIMULATED STREAMFLOW CFS
1200
1100
1000
900
800
700
600
500
400
300
200
100
0.0
40
80
120
160
200
240
280
320
360
DAYS FROM OCTOBER THROUGH SEPTEMBER

APPENDIX C

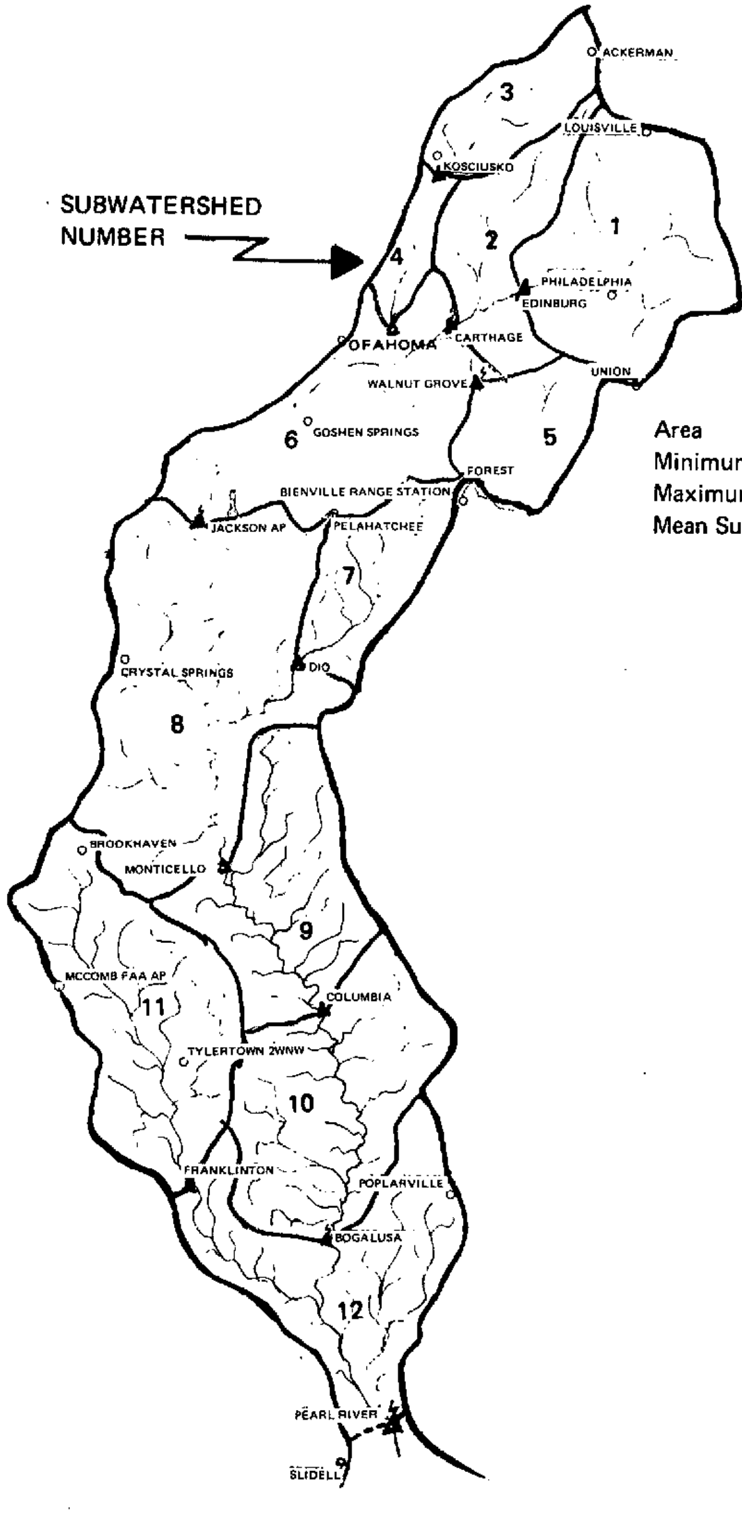
SAMPLE SIMULATION RUN OUTPUT, REGIONAL WATERSHED MODEL

The choice of regional watershed was influenced principally by the fact that it has been modeled and calibrated for river forecasting purposes by the National Weather Service Lower Mississippi River Forecast Center, Slidell, Louisiana, using a model of the same basic type as that used by IBM in this study. It is designated "Pearl River at Pearl River, Louisiana," and is located in the Gulf Plain Physiographic Region, lying mostly in south central Mississippi and a small part of Louisiana.

The regional watershed (Figure C-1) has a total area of 22,248 square kilometers (8,590 square miles) and is composed of 12 watersheds, each with its own stream gage. The water year 1968 was the one for which most accurate overall simulation was achieved. A total of 12 hourly and 25 daily precipitation stations were used to calculate mean basin precipitation for each subwatershed. Table C-1 lists some of the characteristics of interest pertaining to the subwatersheds and their associated precipitation and streamflow data. Approximately half the population of the basin in concentrated in and around the city of Jackson, Mississippi. The topography varies from nearly flat land near the Gulf Coast to gentle hills near the northern end.

The observed daily discharge data for the regional watershed and subwatershed 12, used in the original model for calibration, are shown in Table C-2. Similar tables were used for the other subwatersheds.

Page C-5 and subsequent pages of this appendix contain a reproduction of portions of a printout from one simulation run in which the parameter BMIR was perturbed by -50% for each subwatershed. In order to exercise some restraint on the bulk of this report, only portions of the printout related to subwatershed 12 are included, plus some statistical and storm analysis summaries for all subwatersheds. Original printouts include the same data for all 12 subwatersheds. Print plots have been omitted in favor of SC4020 plots. The symbols "R" and "S" in the plots signify reference and simulated, respectively.



Area	22,248 km^2
Minimum Elevation	0 m
Maximum Elevation	197 m
Mean Surface Slope	0.019

Figure C-1. Pearl River Regional Watershed

Table C-1. Pearl River Subwatershed Characteristics Summary

SWS NO.	SUBWATERSHED NAME	STREAM GAGE EL, m	SWS AREA, km^2	AVERAGE DISCHARGE		LOW DISCHARGE		PEAK DISCHARGE		ANNUAL RAINFALL	
				LONG TERM	REF. YEAR	LONG TERM	REF. YEAR	LONG TERM	REF. YEAR	LONG TERM	REF. YEAR
1	PEARL RIVER AT EDINBURG, MS	104	2326	29.4	36.7	.048	.76	889	306	137	151
2	PEARL RIVER AT CARTHAGE, MS	96	1163	37.1	55.5	.88	1.22	515	442	132	145
3	YOCKANOOKANY RIVER NEAR KOSCIUSKO, MS	114	813	10.8	17.1	.07	.34	546	246	132	166
4	YOCKANOOKANY RIVER NEAR OFAHOMA, MS	95	440	17.4	24.5	.14	1.13	586	286	135	160
5	TOSCOLAMETA CREEK AT WALNUT GROVE, MS	101	1064	13.2	19.1	.07	.11	979	166	142	125
6	PEARL RIVER AT JACKSON, MS	72	2222	106	125	1.27	3.08	2406	848	130	112
7	STRONG RIVER AT DIO, MS	79	1111	15.3	16.3	.34	.48	702	133	132	129
8	PEARL RIVER NEAR MONTICELLO, MS	448	3913	170	186	7.61	7.8	1797	969	1421	123
9	PEARL RIVER NEAR COLUMBIA, MS	*	1684	*	204	*	2.07	*	1006	147	122
10	PEARL RIVER NEAR BOGALUSA, LA	16.8	2435	246	227	28.9	14.6	2496	1030	150	104
11	BOGUE CHITTO RIVER AT FRANKLINTON, LA	*	2551	*	26.3	*	.35	*	270	157	91
12	PEARL RIVER AT PEARL RIVER, LA	0.1	2525	280	275	44.7	1.05	3246	1095	163	106

NOTES: Discharges are in cubic meters per second.
Rainfall is in centimeters.
Long term annual rainfall is an approximation from weather data.
Reference year is water year 1968, reference simulation run.
*Data not obtained.

Table C-2. Pearl River Watershed Observed Discharge Data, WY 1968

SWS No. 12

PEARL RIVER BASIN

2-4926. Pearl River at Pearl River, La.

Location.--Lat 30°23'08", long 89°44'12", in $NE\frac{1}{4}$ sec.1, T.8 S., R.14 E., St. Helena meridian, on right bank fender at downstream side of West Pearl River bridge on U.S. Highway 11, 500 ft upstream from Southern Railway System bridge, 0.5 mile upstream from old channel, and 0.8 mile northeast of town of Pearl River.

Drainage area.--8,590 sq mi (including East Pearl River).

Records available.--Discharge: October 1963 to September 1968. Daily discharge October 1961 to September 1963 in files of Corps of Engineers, Mobile district.
Gage heights: Since June 6, 1906, in reports of U.S. Weather Bureau. Oct. 1, 1899, to May 31, 1906, (collected by Southern Railway System) on file at the U.S. Weather Bureau, Meridian, Miss.

Gage.--West Pearl: Water-stage recorder. Datum of gage is 0.36 ft above mean sea level. Supplementary water-stage recorder since June 18, 1964, 500 ft downstream at same datum. Auxiliary water-stage recorder 7.4 miles upstream. Datum of auxiliary gage is mean sea level.
East Pearl: Water-stage recorder used for gage heights below 13.5 ft. Datum of gage is mean sea level. Supplementary staff gage 9.8 miles upstream at same datum. Auxiliary water-stage recorder 6.5 miles downstream. Datum of auxiliary gage is 0.12 ft below mean sea level.

All levels by Corps of Engineers, datum of 1929.

Average discharge.--5 years, 9,907 cfs.

Extremes.--Maximum discharge during year, 31,600 cfs Jan. 5 (gage height, 14.43 ft); minimum daily, 2,150 cfs Oct. 18, 19.
1963-68: Maximum discharge, 114,700 cfs (gage height, 17.61 ft) Feb. 18, 1966; minimum daily, 1,580 cfs Oct. 24, Nov. 10, 1963.
Maximum stage reported by U.S. Weather Bureau, 18.6 ft Mar. 16, 1921, maximum stage reported by the Southern Railway System at railroad gage, 19.7 ft Apr. 19, 1900. Flood of 1874 reached a stage of 20.2 ft (furnished by Corps of Engineers).

Remarks.--Records good. Records of daily discharge are the combined flow of the entire flood plain of the West and East Pearl Rivers. Flow is affected by tide below about 4,000 cfs.

Cooperation.--Gage-height record, 9 discharge measurements, and computation of daily discharge furnished by Corps of Engineers; records reviewed by Geological Survey.

DISCHARGE, IN CFS, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2,460	3,180	2,550	26,000	16,100	6,760	18,200	9,570	9,000	2,730	3,650	2,560
2	2,470	3,310	2,650	27,000	14,900	7,230	17,600	10,600	9,300	2,750	3,280	2,440
3	2,490	3,350	2,510	29,100	14,500	7,790	17,300	11,000	8,890	2,810	3,260	2,420
4	2,490	3,220	2,650	29,200	14,600	8,470	17,300	11,800	7,450	2,880	3,210	2,470
5	2,430	3,270	2,860	31,100	14,600	9,170	18,200	12,300	6,160	2,960	3,110	2,470
6	2,370	3,270	3,080	31,200	14,300	9,580	18,500	12,400	5,680	2,870	3,020	2,520
7	2,390	3,090	3,350	29,700	12,900	9,560	19,400	12,400	5,400	3,010	2,790	2,710
8	2,440	2,800	3,510	27,200	11,100	9,370	20,000	12,600	5,140	3,400	2,670	2,750
9	2,310	2,560	4,170	25,000	9,450	9,190	20,100	12,600	4,800	3,480	2,580	2,670
10	2,280	2,490	5,420	25,300	8,520	9,140	19,900	12,200	4,610	3,280	2,500	2,730
11	2,250	2,440	7,080	23,800	8,030	9,170	20,000	11,500	4,390	3,040	2,440	2,590
12	2,210	2,420	8,700	23,300	7,870	9,700	19,800	10,500	4,300	2,910	2,430	2,470
13	2,220	2,310	10,600	23,300	7,640	10,600	20,200	9,550	4,320	2,790	2,870	2,390
14	2,200	2,280	11,900	24,100	7,290	10,100	21,300	10,100	4,000	2,750	3,760	2,320
15	2,230	2,280	11,200	24,800	6,860	9,000	22,100	11,800	3,900	2,670	4,770	2,370
16	2,370	2,340	9,960	25,200	6,470	8,920	22,500	13,700	3,680	2,650	4,790	2,470
17	2,310	2,310	9,290	25,900	6,220	10,400	23,100	15,200	3,570	2,620	4,320	2,580
18	2,150	2,270	11,000	26,600	6,160	11,400	22,800	16,100	3,380	2,740	4,290	3,060
19	2,150	2,280	16,200	26,800	6,360	12,100	22,300	16,900	3,180	2,800	4,130	3,680
20	2,250	2,300	22,000	26,900	6,950	12,200	21,500	17,300	3,050	2,940	4,010	4,200
21	2,320	2,280	26,900	26,500	7,480	11,900	20,500	17,400	3,050	3,080	3,970	4,180
22	2,400	2,250	26,400	26,500	7,540	12,600	18,800	16,600	3,150	3,160	3,860	3,890
23	2,470	2,250	24,200	26,500	7,190	13,700	17,500	15,600	3,590	3,450	3,710	3,510
24	2,490	2,260	23,500	26,400	6,860	15,200	15,300	14,800	4,000	3,760	3,530	3,170
25	2,430	2,250	23,700	26,500	6,570	17,500	13,100	15,500	4,250	4,850	3,590	2,920
26	2,310	2,210	24,100	26,400	6,550	19,100	11,400	15,000	4,210	4,100	3,630	2,780
27	2,310	2,260	23,800	25,800	6,570	20,100	10,800	13,500	3,880	3,750	3,540	2,790
28	2,280	2,410	24,600	24,600	6,660	20,700	10,100	11,500	3,540	3,220	3,330	2,690
29	2,370	2,580	24,900	22,800	6,760	20,400	8,910	10,400	3,210	3,040	3,330	2,740
30	2,420	2,620	25,600	20,800	------	19,900	8,440	9,300	2,890	3,010	3,190	2,830
31	3,360	-----	26,000	18,700	------	19,100	------	8,760	------	3,390	2,820	-----
TOTAL	74,130	77,140	424,800	803,000	263,000	380,050	536,950	398,660	140,060	96,890	106,400	85,370
MEAN	2,391	2,571	13,703	25,900	9,069	12,260	17,898	12,860	4,669	3,125	3,432	2,846
MAX	3,360	3,350	26,900	31,200	16,100	20,700	23,100	17,400	9,300	4,850	4,790	4,200
MIN	2,150	2,210	2,510	18,700	6,160	6,760	8,440	8,760	2,890	2,620	2,430	2,320
CFSM	.278	.299	1.60	3.02	1.06	1.43	2.08	1.50	.544	.364	.400	.331
IN.	.32	.33	1.84	3.48	1.14	1.64	2.32	1.72	.61	.42	.46	.37

CAL YR 1967:	TOTAL	2,454,350	MEAN	6,724	MAX	30,800	MIN	2,150	CFSM	0.783	IN.	10.62
WAT YR 1968:	TOTAL	3,386,450	MEAN	9,253	MAX	31,200	MIN	2,150	CFSM	1.08	IN.	14.65

```
SWS12     *PEARL RIVER NR PEARL CITY, LA.  SWS 12  (8590 SQ MI) WY 68
          *CONTROL OPTIONS (BALANCE OF DATA VARIES WITH SPECIFIED OPTIONS)
 *(1)  (2)  (3)  (4)  (5)  (6)  (7)  (8) (9)(10)(11)(12) (13)(14)(15)(16)
   0    1    2    1    1    1    0    0   1   0   0   1    0   1   3   1
 * TIME - AREA HISTOGRAM DEFINITION
 * NBTRI- BTRI(1)  (2)  (3)   (4)   (5)   (6)   (7)   (8)   (9(  (10)
 57
 .0060  .0060  .0060  .0060  .0060  .0060
 .0105  .0105  .0105  .0105  .0105  .0105
 .0171  .0171  .0171  .0171  .0171  .0171
 .0342  .0342  .0342  .0342  .0342  .0342
 .0352  .0352  .0352  .0352  .0352  .0352
 .0299  .0299  .0299  .0299  .0299  .0299
 .0124  .0124  .0124  .0124  .0124  .0124
 .0092  .0092  .0092  .0092  .0092  .0092
 .0097  .0097  .0097  .0097  .0097  .0097
 .0050  .0049  .0049
 59000.   * OUTPUT PARAMETER -  RMPF, IF ANY DAILY FLOW EXCEEDS RMPF
 * WATERSHED PARAMETERS - RGPMB - AREA  -  AREARW - FIMP  -  FWTR
                          1.0     975.0     8590.0   0.069    0.080
 * SOIL MOISTURE PARAMETERS
 * VINTMR-BUZC- SUZC - LZC - ETLF - SUBWF - GWETF- SIAC - BMIR - BIVF
   0.15   0.60  .40    7.00  0.20   0.0     0.0    0.60   6.0   0.60
 * OVERLAND FLOW PARAMETERS - OFSS - OFSL - OFMN - OFMNIS - IFRC
                            .017   6914.0  0.066  0.015    0.415
 *CHANNEL ROUTING AND GROUND WATER PARAMETERS
 *    CSRX - FSRX - CHCAP - EXQPV - BFNLR - BFRC
     0.96   0.96  35000.    0.25    0.80   0.96
 *MOISTURE STORAGE VALUES - GWS  -   UZS - LZS   -   BFNX  -   IFS
                            0.07     0.30  3.00     0.50      0.0
          * STORM ANALYSIS CONFIGURATION    WY 68
 0
 0.0
 0.0
 4        *(JULDI) NUMBER OF JULIAN DATES REQUESTED FOR RUNOFF PLOTS OF
          * HOURLY OBSERVED AND SIMULATED STREAM FLOWS
 301 169   21 169   130 169   224 169
          * LAST TWO DIGITS IN THE CALENDER YEARS OF THE WATER YEAR TO BE RUN
 67 68    * YEAR1 - YEAR2
          * EVAPORATION DATA - PEARL RIVER SWS NO. 5   WY 68
          * IF CONOPT(1)=2  ANNUAL EVAPORATION TOTAL IS READ                 27
 38.0     * EPAET, ESTIMATED POTENTIAL ANNUAL EVAPOTRANSPIRATION
          * IF CONOPT(1)=2  MEAN ANNUAL NUMBER OF RAINY DAYS IS READ         28

 107.0 * MNRD, MEAN ANNUAL NUMBER OF RAINY DAYS
       * STREAMFLOW DATA  - PEARL RIVER SWS NO. 12  WY 68     (REF.)
       * MEAN DAILY OBSERVED STREAMFLOW IN CFS (REF.)                        29
    37.    36.    94.   364.   979.   985.   976.  1068.  1457.  1130.     *OCT
  1019.   996.   995.   998.  1035.  1105.  2136.  2048.  1220.  1388.     *OCT
  1910.  1520.   990.   970.   972.   964.   915.   992.  1647.  3245.     *OCT
  6643.                                                                    *OCT
  4393.  3057.  2922.  3336.  2374.  1969.  1841.  1516.  1503.  1357.     *NOV
  1285.  1379.  1793.  1800.  1785.  1692.  1603.  1344.  1083.   947.     *NOV
   885.   847.   813.   780.   748.   723.   709.   676.   634.   607.     *NOV
   582.   558.   541.   523.   677.  1286.  2131.  1581.   938.  3612.     *DEC
  7597.  6099.  4423.  6245.  7935.  6312.  6108.  8874. 16732. 18578.     *DEC
 15887. 17222. 23982. 25164. 26134. 25971. 25736. 26166. 27599. 29243.     *DEC
 31246.                                                                    *DEC
 29621. 31299. 31526. 30951. 32766. 32630. 25741. 21668. 21925. 25186.     *JAN
 26443. 24291. 22450. 23100. 25863. 26832. 25435. 25557. 26178. 26540.     *JAN
 28017. 28964. 30538. 34331. 38699. 36626. 30374. 22949. 18978. 17110.     *JAN
 16697.                                                                    *JAN
 17148. 17525. 17256. 17284. 18109. 20292. 22140. 20738. 17540. 15217.     *FEB
 14564. 14201. 13361. 12501. 11612. 11748. 11167. 10944. 11434. 10308.     *FEB
  9876.  9836. 10536. 10328.  9549.  9765. 10413. 11293. 12450.            *FEB
```

```
12910. 11401. 11655. 12802. 13014. 11645. 12001. 11911. 11995. 11729.        *MAR
12130. 13394. 12426. 13107. 13848. 12055.  9899.  8632.  8360.  9031.        *MAR
10342. 12671. 22024. 17523. 16719. 22017. 25212. 21925. 18134. 17713.        *MAR
15627.                                                                       *MAR
14622. 14418. 15108. 14860. 17483. 22746. 27523. 28797. 24503. 19934.        *APR
14598. 13233. 17617. 23786. 24025. 20675. 21250. 28062. 30492. 27589.        *APR
22780. 21192. 21542. 21105. 18897. 16064. 14087. 13297. 14116. 15110.        *APR
13812. 13049. 13505. 14140. 12988. 12124. 13302. 15246. 16044. 15030.        *MAY
15599. 17649. 18794. 15954. 14154. 13594. 12385. 11478. 11174. 12205.        *MAY
14447. 15650. 16080. 14909. 15199. 14399. 13717. 14290. 13779. 11482.        *MAY
10568.                                                                       *MAY
10625. 10363.  9083.  8302.  7762.  7356.  7369.  8209.  9235.  9672.        *JUN
 8550.  7866.  7473.  6612.  6046.  5696.  5308.  4967.  4739.  4578.        *JUN
 4413.  4781.  4920.  4446.  4444.  4695.  4606.  4319.  3940.  3574.        *JUN
 3379.  3554.  3729.  3765.  3658.  3993.  3900.  3341.  3128.  2799.        *JUL
 2731.  2787.  2566.  2195.  2262.  2284.  2063.  1831.  1956.  1987.        *JUL
 1969.  2454.  4207.  4181.  2703.  2276.  2692.  2738.  2139.  2142.        *JUL
 1913.                                                                       *JUL
 1647.  2394.  2683.  2225.  2797.  2807.  2480.  1720.  1255.  1404.        *AUG
 1545.  1383.  1731.  1994.  2486.  2899.  2900.  2824.  1555.  1430.        *AUG
 1418.  1222.  1207.  1300.  1571.  1643.  1765.  1826.  1865.  2056.        *AUG
 1585.                                                                       *AUG
 1074.   936.  1113.  1254.  1054.  1255.  1742.  2142.  1746.  1220.        *SEP
 1364.  1138.   981.   709.   644.  1254.  2862.  4757.  3785.  2534.        *SEP
 2382.  2381.  1633.   963.   848.   755.   667.   777.  1189.  1204.        *SEP
         * RAINFALL DATA  -   PEARL RIVER SWS NO. 12  WY 68
0       * NSGRD
         * HOURLY RAINFALL TOTALS FROM BASE RECORDING GAGE
         * NO CARDS REQUIRED FOR PERIODS WITH NO RAINFALL
         * WBG. NUMBER OF WEATHER BUREAU PRECIPITATION GAGE
         * YEAR. LAST TWO DIGITS OF THE CURRENT YEAR
         * MONTH. CURRENT MONTH OF THE YEAR
         * DATE. CURRENT DAY OF THE MONTH (1 - 31)
         * CN = 1 FOR A.M.; CN = 2 FOR P.M.
*WBG YR MO DY CN     HOURLY RAINFALL TOTALS IN CHRONOLOGICAL ORDER                 33
0012 67 10  8 1 0.00 0.00 0.00 0.28 0.01 0.01 0.00 0.00 0.01 0.00 0.00 0.00
0012 67 10 16 1 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0012 67 10 16 2 0.19 0.07 0.01 0.02 0.01 0.01 0.01 0.03 0.16 0.09 0.02 0.01
0012 67 10 30 1 0.00 0.00 0.00 0.02 0.38 0.05 0.15 0.24 0.25 0.18 0.07 0.02
```

(REMAINING HOURLY RAINFALL DATA INTENTIONALLY OMITTED)

```
        * STORM DATA - PEARL RIVER SUB WS NO. 12    WY 68
*PEARL RIVER NP PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) 10/28/67
1.0   8590. 169  -1  1
1.   981.0 981.2
967.7 966.5 961.8 959.5 922.7 920.7 896.9 897.0 874.4 833.8 844.8 862.1 894.0
920.8 961.6 991.8 1053.0 1102.8 1158.4 1210.0 1269.2 1355.5 1409.7 1466.7 1511.3
1569.2 1624.8 1683.3 1700.5 1743.0 1755.8 1786.9 1415.5 1393.8 1411.8 1428.2
1456.5 1465.6 1480.6 1506.5 1594.6 1668.1 1773.4 1860.4 2348.5 2484.9 2559.6
2615.8 2644.0 2677.2 2708.0 2760.6 2799.3 2889.3 2819.3 2945.6 2685.4 2784.8
2916.1 3038.4 3166.5 3283.6 3403.6 3531.1 3681.5 3805.1 4119.8 4256.3 4786.2
5014.3 5186.2 5367.5 5552.8 5790.2 6035.9 6282.5 6465.6 6687.7 6577.2 6762.4
6545.4 6654.9 6811.8 6955.4 7084.0 7169.0 7231.6 7212.7 7188.6 7096.4 7298.8
7113.1 7278.2 7088.0 6859.8 6615.1 6363.5 6130.1 5904.0 5694.3 5478.0 5313.1
4845.6 4722.8 4229.0 4049.0 3908.7 3764.4 3620.6 3453.7 3280.8 3101.2 2979.7
2845.2 3057.9 2972.0 3146.6 3094.9 3033.9 2972.9 2915.0 2903.4 2904.6 2919.1
2905.5 2926.7 2663.3 2734.2 2731.7 2794.5 2868.4 2941.0 3020.2 3081.3 3138.4
3177.9 3234.9 3253.2 3573.9 3540.1 3580.2 3578.6 3538.4 3488.8 3420.5 3326.0
3222.4 3152.1 3082.2 3057.0 2726.5 2709.4 2612.2 2563.0 2561.2 2585.8 2619.2
2633.2 2647.7 2650.0 2698.7 2692.3 3000.8 2985.2 3050.1 3098.3
```

```
*PEARL RIVER NR PEARL CITY. LA. SWS NO.12 (8590 SQ. MI) 01/21/68
1.0 8590. 169 -1 1
1.0
27264.5 27371.8 27451.3 27559.4 27640.9 27724.0 27755.9 27847.6 27826.6 27872.7
27840.2 27873.9 27920.6 27974.3 28034.3 28115.8 28183.9 28287.0 28398.4 28445.8
28631.3 28675.6 28814.0 28896.6 28922.8 28957.8 28950.0 28961.8 28983.7 28983.8
28980.4 29002.7 28903.7 28917.2 28798.3 28792.9 28799.1 28806.0 28826.4 28859.1
28882.8 28895.0 28927.4 28956.0 29111.6 29162.1 29331.8 29419.9 29512.8 29614.1
29675.2 29736.8 29796.2 29863.1 29939.4 30041.3 30042.8 30155.6 30131.6 30222.9
30330.7 30453.3 30585.6 30738.7 30912.4 31061.7 31232.9 31381.6 31629.5 31751.0
31978.8 32119.9 32254.0 32369.0 32474.9 32602.9 32739.1 32904.5 33075.7 33279.1
33397.9 33623.3 33695.3 33943.7 34205.5 34442.6 34706.2 34922.0 35177.4 35467.9
35744.5 35994.9 36346.2 36581.2 36898.3 37120.1 37352.7 37575.1 37760.2 37887.6
37987.7 38077.6 38166.0 38287.9 38332.4 38495.4 38557.9 38710.0 38855.5 38994.9
39111.0 39222.8 39319.1 39378.3 39399.7 39386.4 39492.1 39470.7 39521.1 39436.4
39269.7 39090.7 38913.3 38744.8 38582.8 38390.4 38147.7 37889.3 37504.9 37221.8
36851.1 36585.6 36343.0 36107.7 35874.1 35653.1 35438.7 35216.9 34984.6 34746.8
34653.7 34438.5 34299.1 34074.2 33832.1 33592.8 33353.6 33117.2 32879.8 32632.1
32353.6 32074.0 31676.2 31380.2 30976.5 30645.8 30308.1 29961.6 29611.2 29260.1
28905.5 28540.3 28169.0 27778.7 27501.3 27118.6 26837.3 26479.8
*PEARL RIVER NR PEARL CITY. LA. SWS NO.12 (8590 SQ. MI) 05/09/68
1.0 8590. 169 -1 1
1.  16757.0 16815.5 16898.8 16940.6 16943.8 16938.0
16887.6 16923.3 16469.7 16457.4 15972.3 15901.9 15872.2 15810.1 15685.8 15620.1
15365.0 15214.8 15118.4 14999.3 15313.0 15195.4 15653.0 15515.3 15486.8 15478.0
15459.6 15461.0 15550.7 15564.6 15662.9 15674.1 15265.8 15258.7 14715.3 14593.2
14532.0 14478.2 14440.1 14385.4 14335.4 14303.7 14338.4 14442.3 14960.5 15018.7
15557.9 15649.5 15680.7 15716.2 15761.6 15854.1 15954.6 16061.3 16001.4 15992.9
15499.3 15424.8 14919.3 14874.1 14963.6 15007.5 15141.3 15204.0 15281.8 15324.9
15406.0 15457.7 15896.5 15930.5 16468.3 16551.9 16622.7 16730.9 16828.7 17024.1
17239.7 17442.4 17550.3 17717.5 17417.4 17457.0 17077.1 17060.8 17204.2 17304.9
17559.8 17733.4 17887.6 18011.3 18132.2 18168.9 18567.2 18573.3 19088.3 19178.3
19255.1 19349.8 19403.3 19463.8 19502.9 19543.9 19534.1 19567.1 19204.6 19203.5
18668.5 18607.3 18538.3 18459.6 18402.5 18325.8 18245.5 18157.9 18106.6 17997.5
18265.0 18167.0 18570.3 18504.4 18378.8 18241.1 18050.4 17867.5 17680.1 17488.2
17247.7 17063.6 16513.7 16312.1 15591.2 15341.8 15142.6 15022.4 14962.7 14796.4
14643.1 14498.5 14409.5 14281.8 14578.5 14569.7 15090.2 15134.6 15116.3 15090.3
15017.6 14973.5 14894.9 14819.4 14690.6 14611.1 14227.7 14171.7 13584.6 13560.1
13579.7 13542.1 13562.6 13572.5 13533.2 13489.4 13526.3 13510.7 13878.7 13879.3
14407.3 14455.0
*PEARL RIVER NR PEARL CITY. LA. SWS NO.12 (8590 SQ. MI) 08/11/68
1.0 8590. 169 -1 1
1.  1656.2
1666.1 1627.7 1613.4 1598.2 1607.2 1536.7 1549.0 1621.0 1627.8 1426.3 1384.1
1391.7 1425.7 1487.5 1512.3 1536.9 1515.2 1565.1 1535.6 1548.3 1529.8 1617.2
1730.9 1744.5 1752.0 1724.8 1726.0 1671.1 1605.8 1462.8 1413.1 1319.8 1283.6
1170.7 1059.6 1048.9 1039.2 1063.7 1057.8 1095.9 1145.7 1276.7 1321.4 1419.6
1480.6 1601.3 1709.2 1715.8 1727.1 1707.9 1737.6 1774.2 1816.0 1765.8 1799.8
1394.5 1413.8 1327.2 1227.8 1231.4 1249.2 1316.4 1408.3 1523.9 1623.1
1796.0 1873.4 2380.3 2440.3 2578.2 2722.0 2764.6 2798.5 2790.1 2793.2 2779.2
2768.8 2684.9 2682.5 1628.1 1547.9 1393.5 1240.6 1199.2 1182.5 1220.2 1237.5
1256.8 1264.0 1351.7 1360.4 2396.1 2402.3 2500.7 2616.5 2620.1 2623.3 2610.9
2612.5 2596.6 2581.6 2468.1 2480.1 1536.4 1650.8 1689.8 1696.5 1793.4 1893.7
2030.9 2138.9 2250.6 2344.2 2503.7 2551.5 3609.0 3680.0 3782.5 3934.6 3986.7
3983.9 3876.4 3799.7 3716.4 3646.4 3507.2 3456.7 2369.7 2309.7 2182.9 2053.9
2043.4 2064.7 2114.3 2125.2 2137.7 2145.8 2243.1 2253.9 3380.4 3328.0 3418.4
3507.1 3469.6 3407.3 3301.6 3205.7 3110.7 3039.5 2899.9 2865.6 2037.5 2071.2
2038.2 1974.6 2011.3 2043.3 2152.8 2346.2 2557.6 2742.7 2975.7 3089.6 3994.2
4013.6 4078.8 4166.3
```

YEARLY STATISTICAL SUMMARY

	MONTHLY		DAILY	
	REFERENCE	SIMULATED	REFERENCE	SIMULATED
MEAN	296673.00	301957.81	9725.67	9899.84
MAXIMUM	839285.00	878819.19	38699.00	44996.41
VARIANCE	0.676E 11	0.752E 11	0.839E 08	0.102E 09
STANDARD DEVIATION	259945.13	274212.31	9160.47	10113.09

	MONTHLY	DAILY
SUM OF (REFERENCE - SIMULATED)	-63902.44	-63907.77
ROOT SUM SQUARE	116637.75	33742.83
SUM SQUARED	0.13	4.99
SUM SQUARED (IBM METHOD)	0.13	4.92
CORRELATION COEFFICIENT	0.9930	0.9882

SUMMARY OF MONTHLY AND ANNUAL TOTALS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
PRECIPITATION	3.170	0.840	8.750	2.490	2.530	3.270	3.020	1.080	3.700	5.430	4.190	3.420	41.890 IN
EVP/TRAN-NET	2.166	1.521	0.958	0.807	0.840	1.173	2.485	3.663	4.758	5.721	5.157	3.575	32.824 IN
-POTENTIAL	3.333	1.761	0.996	0.812	0.848	1.173	2.749	5.231	6.711	7.455	7.709	5.647	44.427 IN
SURFACE RUNOFF	0.186	0.163	1.072	2.025	0.886	0.714	2.097	1.631	0.778	0.479	0.373	0.233	10.638 IN
INTERFLOW	0.0	0.0	0.326	0.264	0.100	0.355	0.191	0.024	0.000	0.0	0.0	0.0	1.261 IN
BASE FLOW	0.058	0.111	0.703	1.581	0.635	0.953	0.592	0.367	0.133	0.080	0.080	0.064	5.358 IN
STREAM EVAP.	0.066	0.073	0.067	0.065	0.068	0.094	0.204	0.214	0.173	0.226	0.213	0.105	1.569 IN
TOTAL RUNOFF(SIM)	0.177	0.200	2.035	3.805	1.553	1.929	2.677	1.809	0.738	0.333	0.240	0.191	15.687 IN
TOTAL RUNOFF(REF)	0.177	0.201	1.626	3.634	1.728	1.878	2.600	1.891	0.840	0.378	0.258	0.201	15.411 IN

REFFRENCE TOTALS	40834.	46401.	375682.	839285.	399134.	433852.	600511.	436746.	193948.	87222.	59618.	46363.	3559596.	CFS
SIMULATED TOTALS	40842.	46310.	470069.	878819.	358757.	445561.	618424.	417737.	170391.	76909.	55473.	44207.	3623494.	CFS

BALANCE 3.6266 INCHES

MONTHLY FLOW CORRELATION COEFFICIENT 0.9930
MEAN DAILY FLOW CORRELATION COEFFICIENT 0.9882

M E A N   D A I L Y   S I M U L A T E D   F L O W S (CFS)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
1	37.	4416.	550.	33928.	14542.	12670.	14549.	12055.	9668.	2865.	1438.	971.	
2	36.	3048.	527.	36517.	15134.	10844.	14720.	11088.	9747.	3050.	2188.	834.	
3	94.	2929.	510.	35186.	14876.	11154.	15878.	11870.	8048.	3234.	2481.	1009.	
4	363.	3323.	494.	34037.	15360.	12936.	15273.	12962.	7102.	3283.	2028.	1152.	
5	978.	2434.	649.	38036.	16553.	13116.	18211.	11894.	6512.	3185.	2600.	960.	
6	984.	2033.	1276.	38506.	19278.	11217.	25888.	10824.	6100.	3435.	2620.	1157.	
7	975.	1913.	2152.	26002.	22279.	11699.	35122.	12271.	6078.	3468.	2307.	1652.	
8	1067.	1580.	1612.	20389.	21153.	11773.	34485.	14573.	7101.	2921.	1552.	2053.	
9	1456.	1610.	931.	21374.	17019.	11894.	25595.	15195.	8434.	2730.	1093.	1672.	
10	1130.	1463.	3791.	27084.	13720.	11164.	18803.	14332.	9217.	2406.	1246.	1148.	
11	1019.	1379.	8900.	28771.	12691.	11872.	12692.	14829.	8095.	2350.	1394.	1313.	
12	995.	1421.	8086.	24365.	12200.	13784.	11500.	16987.	7592.	2421.	1239.	1139.	
13	994.	1797.	5274.	21834.	11401.	12177.	17858.	19205.	7103.	2216.	1595.	995.	
14	997.	1780.	7334.	22682.	10550.	13346.	25258.	16215.	5698.	1856.	1961.	697.	
15	1035.	1754.	9896.	26888.	9650.	14860.	24396.	13952.	5094.	1936.	2341.	590.	
16	1104.	1650.	8199.	28026.	9917.	12480.	20006.	12852.	4778.	1970.	2750.	1184.	
17	2134.	1553.	7939.	25221.	9474.	9594.	21834.	11376.	4426.	1759.	2773.	2781.	
18	2046.	1293.	11008.	25786.	9203.	7905.	30591.	10398.	4118.	1539.	2720.	4666.	
19	1218.	1031.	22736.	26749.	9746.	7716.	32721.	10075.	3925.	1677.	1455.	3694.	
20	1385.	896.	25434.	26790.	8663.	8713.	29917.	11924.	3797.	1719.	1315.	2440.	
21	1906.	836.	21761.	29073.	8301.	10176.	23460.	14536.	3663.	1711.	1304.	2316.	
22	1515.	800.	22014.	30451.	8423.	12585.	21160.	15788.	4062.	2201.	1113.	2325.	
23	985.	768.	31473.	33497.	9323.	23943.	21311.	16795.	4220.	3952.	1096.	1587.	
24	965.	736.	32612.	38932.	9285.	17683.	21219.	15163.	3778.	3926.	1191.	895.	
25	964.	706.	33136.	44996.	8570.	16985.	19038.	15098.	3803.	2480.	1464.	778.	
26	973.	683.	33574.	40160.	8855.	24230.	15432.	14133.	4077.	2052.	1536.	688.	
27	932.	671.	31749.	30795.	9783.	29434.	12575.	13390.	4001.	2461.	1689.	588.	
28	1003.	639.	30361.	19818.	10733.	26066.	11433.	14200.	3734.	2506.	1811.	696.	
29	1655.	593.	31346.	15613.	12078.	19861.	12366.	13728.	3382.	1932.	1821.	1106.	
30	3255.	573.	34953.	13779.		18669.	15134.	10735.	3037.	1953.	1967.	1122.	
31	5644.		38293.	13535.		15016.		9295.		1712.	1482.		
SIMULATED TOTALS	40842.	46310.	470068.	878819.	358757.	445561.	618424.	417737.	170391.	76909.	55473.	44207.	3623494. CFS

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	ANNUAL
STORAGES-UZS	0.600	0.0	0.330	0.0	0.396	0.0	0.342	0.0	0.076	0.213	0.0	0.0	IN
LZS	3.640	3.491	7.818	8.407	8.707	9.109	8.309	6.086	5.028	4.634	3.887	3.723	IN
IFS	0.0	0.0	0.010	0.0	0.029	0.0	0.024	0.0	0.0	0.0	0.0	0.0	IN
GWS	0.089	0.049	1.288	0.678	0.746	0.598	0.503	0.156	0.074	0.073	0.047	0.056	IN
INDICES- UZC	0.486	0.341	0.250	0.250	0.250	0.250	0.414	0.708	0.907	0.975	1.017	0.739	
BFNX	0.265	0.135	1.462	0.996	0.986	0.848	0.697	0.287	0.147	0.115	0.075	0.078	
SIAM	1.024	0.791	0.580	0.481	0.474	0.539	0.864	1.239	1.497	1.614	1.663	1.463	

DAILY FLOW DURATION AND ERROR TABLE

FLOW INTERVAL	CASES	AV.ERROR	AVR. ABS. ERROR	STANDARD ERROR
0.0-	0.0			
1.0-	0.0			
1.6-	0.0			
2.7-	0.0			
4.5-	0.0			
7.4-	0.0			
12.2-	0.0			
20.1-	0.0			
33.1-	2.0	-0.2	0.24	0.34
54.6-	0.0			
90.0-	1.0	-0.3	0.29	
148.4-	0.0			
244.7-	1.0	-1.0	1.02	
403.4-	7.0	-35.3	35.31	8.73
665.1-	37.0	-30.6	33.41	35.01
1096.6-	49.0	-57.4	75.99	72.91
1808.0-	47.0	-165.3	174.70	127.08
2981.0-	30.0	-370.1	440.88	354.38
4914.8-	18.0	22.5	1095.15	1264.19
8103.1-	57.0	-786.9	893.39	734.49
13359.7-	70.0	-115.0	1340.33	2031.32
22026.5-	45.0	2980.8	3075.42	2715.25
	364.0	148.6	905.22	17175.13
CORRELATION COEFFICIENT (DAILY)			0.9882	

TWENTY HIGHEST CLOCKHOUR RAINFALL EVENTS IN THE WATER YEAR
1.230 0.920 0.640 0.550 0.540 0.530 0.490 0.490 0.480 0.470 0.450 0.410 0.390 0.380 0.380 0.380 0.360 0.360 0.360 0.350

TWENTY HIGHEST CLOCKHOUR OVERLAND FLOW RUNOFF EVENTS IN THE WATER YEAR
0.305 0.290 0.186 0.117 0.105 0.102 0.094 0.090 0.077 0.075 0.068 0.065 0.062 0.055 0.054 0.054 0.052 0.052 0.047 0.042

DAILY SOIL MOISTURE

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
2	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
3	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
4	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
5	3.	4.	3.	3.	8.	9.	9.	8.	6.	5.	5.	4.
6	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
7	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
8	3.	4.	3.	8.	8.	9.	9.	8.	6.	5.	5.	4.
9	3.	4.	5.	8.	8.	9.	9.	8.	5.	5.	4.	4.
10	3.	4.	6.	8.	8.	9.	9.	8.	5.	5.	4.	4.
11	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	4.	3.
12	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	4.	3.
13	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	4.	3.
14	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	4.	3.
15	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	4.	3.
16	3.	4.	6.	8.	8.	9.	9.	7.	5.	5.	5.	3.
17	3.	4.	6.	8.	8.	9.	9.	7.	5.	4.	5.	4.
18	3.	4.	7.	8.	8.	9.	9.	7.	5.	4.	5.	4.
19	3.	4.	7.	8.	8.	9.	9.	7.	5.	4.	5.	4.
20	3.	4.	7.	8.	8.	9.	9.	7.	5.	4.	4.	4.
21	3.	4.	7.	8.	8.	9.	9.	6.	5.	4.	4.	4.
22	3.	4.	7.	8.	8.	9.	8.	6.	5.	5.	4.	4.
23	3.	4.	7.	8.	9.	9.	8.	6.	5.	5.	4.	4.
24	3.	4.	7.	8.	9.	9.	8.	6.	5.	5.	4.	4.
25	3.	4.	7.	8.	9.	9.	8.	6.	5.	5.	4.	4.
26	3.	4.	7.	8.	9.	9.	8.	6.	5.	5.	4.	4.
27	3.	4.	8.	8.	9.	9.	8.	6.	5.	5.	4.	4.
28	2.	4.	8.	8.	9.	9.	8.	6.	5.	5.	4.	4.
29	2.	4.	8.	8.	9.	9.	8.	6.	5.	5.	4.	4.
30	3.	3.	8.	8.		9.	8.	6.	5.	5.	4.	4.
31	4.		8.	8.		9.		6.		5.	4.	

MULTI= 0 CONOPT(10)= 0 CONOPT(15)= 3 IBFLAG= 1 KWMAIN= 2

MULTI= 0 CONOPT(10)= 0 CONOPT(15)= 3 IBFLAG= 10 KWMAIN= 6

IDFLAG= 11 IENDFG= 0 ISFLAG= 10 MAIN= 30

IDFLAG= 11 IENDFG= 1 ISFLAG= 10 MAIN= 23

PEARL RIVER, LA. (8590 SQ MI) STORM 10/28/67 STUDY RW51

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	7298.8	7310.0	12.20	0.2	
ANNUAL PEAK(CFS)		16550.0			0.1
PEAK(HR)	93	95	2	2.2	
RUNOFF(IN)	0.0987	0.0989	0.0002	0.2	

PEARL RIVER, LA. (8590 SQ MI) STORM 01/21/68 STUDY RW51

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	39521.1	46266.9	6745.90	17.1	
ANNUAL PEAK(CFS)		16550.0			40.8
PEAK(HR)	119	114	-5	4.2	
RUNOFF(IN)	0.9799	1.0682	0.0883	9.0	

PEARL RIVER, LA. (8590 SQ MI) STORM 05/09/68 STUDY RW51

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	19567.1	19886.4	319.90	1.6	
ANNUAL PEAK(CFS)		16550.0			1.9
PEAK(HR)	104	104	0	0.0	
RUNOFF(IN)	0.4872	0.4764	0.0108	2.2	

PEARL RIVER, LA. (8590 SQ MI) STORM 08/11/68 STUDY RW51

	REFERENCE	SIMULATED	DIFF	%DIFF	%ANNUAL DIFF
PEAK(CFS)	4166.3	4056.4	-109.30	2.6	
ANNUAL PEAK(CFS)		16550.0			0.7
PEAK(HR)	168	168	0	0.0	
RUNOFF(IN)	0.0641	0.0599	0.0042	6.6	

REGIONAL WATERSHED TOTAL DAILY STREAMFLOW STATISTICAL SUMMARY FOR 12 SUB WATERSHEDS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF R-S	ROOT SUM SQUARE	CORR COEFF
SUB WATERSHED 1							
REFERENCE WY 68	1295	10824	0.257E 07	1602			
SIMULATED	1312	16600	0.412E 07	2030	-6183	11635	0.9712
SUB WATERSHED 2							
REFERENCE WY 68	1959	15621	0.574E 07	2396			
SIMULATED	1988	20559	0.866E 07	2942	*****	15290	0.9758
SUB WATERSHED 3							
REFERENCE WY 68	602	8699	0.769E 06	876			
SIMULATED	612	12258	0.120E 07	1095	-3544	5768	0.9774
SUB WATERSHED 4							
REFERENCE WY 68	865	10121	0.138E 07	1172			
SIMULATED	879	13142	0.206E 07	1433	-5349	7154	0.9786
SUB WATERSHED 5							
REFERENCE WY 68	675	5888	0.807E 06	898			
SIMULATED	686	8321	0.120E 07	1096	-4152	5256	0.9816
SUB WATERSHED 6							
REFERENCE WY 68	4402	29958	0.257E 08	5065			
SIMULATED	4480	37721	0.350E 08	5918	*****	24993	0.9837
SUB WATERSHED 7							
REFERENCE WY 68	576	4702	0.519E 06	720			
SIMULATED	588	5842	C.805E 06	897	-4294	4455	0.9822
SUB WATERSHED 8							
REFERENCE WY 68	6584	34246	0.487E 08	6977			
SIMULATED	6691	41231	0.614E 08	7834	*****	28704	0.9862
SUB WATERSHED 9							
REFERENCE WY 68	7227	35552	0.549E 08	7408			
SIMULATED	7349	41679	0.681E 08	8253	*****	29355	0.9867
SUB WATERSHED 10							
REFERENCE WY 68	8010	36403	0.629E 08	7931			
SIMULATED	8148	42091	0.776E 08	8808	*****	30693	0.9872
SUB WATERSHED 11							
REFERENCE WY 68	927	9524	0.139E 07	1178			
SIMULATED	943	15437	0.222E 07	1488	-5633	7961	0.9780
REGIONAL WATERSHED							
REFERENCE WY 68	9725	38699	0.839E 08	9160			
SIMULATED	9899	44996	0.102E 09	10113	*****	33742	0.9882

REGIONAL WATERSHED TOTAL MONTHLY STREAMFLOW STATISTICAL SUMMARY FOR 12 SUB WATERSHEDS

	MEAN (CFS)	MAXIMUM (CFS)	VARIANCE	STD DEV	SUM OF R-S	ROOT SUM SQUARE	DRIEST MONTH ** (CFS)	CORR COEFF
SUB WATERSHED 1								
REFERENCE WY 68	39506	102115	0.140E 10	37461			2200 (12)	
SIMULATED	40021	106822	0.164E 10	40533	-6181	22193	1914 (12)	0.9885
SUB WATERSHED 2								
REFERENCE WY 68	59766	177911	-.976E 09	57608			4756 (1)	
SIMULATED	60661	177690	-.471E 09	61834	-10741	34795	4694 (1)	0.9872
SUB WATERSHED 3								
REFERENCE WY 68	18391	62597	0.387E 09	19664			1511 (1)	
SIMULATED	18686	72423	0.472E 09	21722	-3543	10558	1521 (1)	0.9932
SUB WATERSHED 4								
REFERENCE WY 68	26391	80511	0.770E 09	27744			2812 (2)	
SIMULATED	26837	92104	0.937E 09	30610	-5348	15908	2789 (2)	0.9914
SUB WATERSHED 5								
REFERENCE WY 68	20597	57654	0.437E 09	20912			560 (12)	
SIMULATED	20943	58737	0.496E 09	22260	-4152	9554	483 (12)	0.9932
SUB WATERSHED 6								
REFERENCE WY 68	134289	401045	-.525E 09	129055			12782 (2)	
SIMULATED	136651	405248	0.186E 10	137978	-28340	68476	12360 (2)	0.9904
SUB WATERSHED 7								
REFERENCE WY 68	17582	54248	0.284E 09	16838			1112 (1)	
SIMULATED	17940	57904	0.326E 09	18054	-4294	6976	1101 (1)	0.9954
SUB WATERSHED 8								
REFERENCE WY 68	200823	589726	0.913E 09	187811			17468 (1)	
SIMULATED	204112	604156	0.633E 09	198210	-39470	92078	17227 (12)	0.9913
SUB WATERSHED 9								
REFERENCE WY 68	220437	618703	0.167E 10	200805			18297 (1)	
SIMULATED	224169	629941	0.156E 10	210962	-44790	97736	18369 (1)	0.9911
SUB WATERSHED 10								
REFERENCE WY 68	244307	695353	0.118E 10	220066			21190 (1)	
SIMULATED	248534	721851	0.191E 10	231195	-50724	100928	21280 (1)	0.9923
SUB WATERSHED 11								
REFERENCE WY 68	28302	69188	0.567E 09	23821			3195 (11)	
SIMULATED	28771	70907	0.645E 09	25403	-5632	11182	2970 (11)	0.9929
REGIONAL WATERSHED								
REFERENCE WY 68	296633	839285	-.115E 10	259945			40834 (1)	
SIMULATED	301957	878819	-.212E 10	274212	-63902	116637	40842 (1)	0.9930

**- THE MONTHS OF A GIVEN WATER YEAR ARE NUMBERED AS FOLLOWS:

NO	1	2	3	4	5	6	7	8	9	10	11	12
MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT

REGIONAL WATERSHED TOTAL STORM ANALYSIS SUMMARY FOR 12 SUB WATERSHEDS

	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)	PEAK (CFS)	(HR)	R/O (IN)
	10/15/67			01/08/68			04/26/68			08/18/68		
SUB WATERSHED 1												
REFERENCE WY 68	320	104	0.045	8794	123	1.609	3508	126	0.749	371	95	0.059
SIMULATED	324	104	0.045	12048	119	1.887	4088	123	0.761	348	95	0.053
	10/15/67			01/08/68			04/26/68			08/18/68		
SUB WATERSHED 2												
REFERENCE WY 68	979	73	0.071	15907	111	1.987	4398	119	0.622	524	93	0.055
SIMULATED	972	73	0.071	21257	111	2.395	4863	122	0.609	496	93	0.050
	10/15/67			01/09/68			04/25/68			07/31/68		
SUB WATERSHED 3												
REFERENCE WY 68	315	70	0.095	4757	78	2.170	1156	104	0.521	298	69	0.117
SIMULATED	325	72	0.099	6010	74	2.377	1482	104	0.565	288	69	0.109
	10/15/67			01/09/68			04/26/68			07/31/68		
SUB WATERSHED 4												
REFERENCE WY 68	388	110	0.097	6539	114	2.401	1451	120	0.450	368	109	0.113
SIMULATED	405	110	0.103	8079	114	2.792	1835	120	0.477	351	109	0.104
	10/15/67			01/09/68			04/25/68			08/13/68		
SUB WATERSHED 5												
REFERENCE WY 68	202	84	0.036	5753	80	1.907	3056	118	0.921	392	108	0.086
SIMULATED	201	84	0.036	7033	75	2.092	3613	118	0.939	384	108	0.082
	10/15/67			01/09/68			04/26/68			08/15/68		
SUB WATERSHED 6												
REFERENCE WY 68	2501	94	0.093	30736	117	1.821	14331	128	0.680	1482	94	0.058
SIMULATED	2533	94	0.094	39061	112	2.134	15595	128	0.673	1431	94	0.055

	10/15/67			01/08/68			04/26/68			08/14/68		
SUB WATERSHED 7												
REFERENCE WY 68	82	69	0.029	4883	83	1.557	1860	101	0.610	343	93	0.127
SIMULATED	85	73	0.030	6137	83	1.735	2560	101	0.691	422	93	0.135

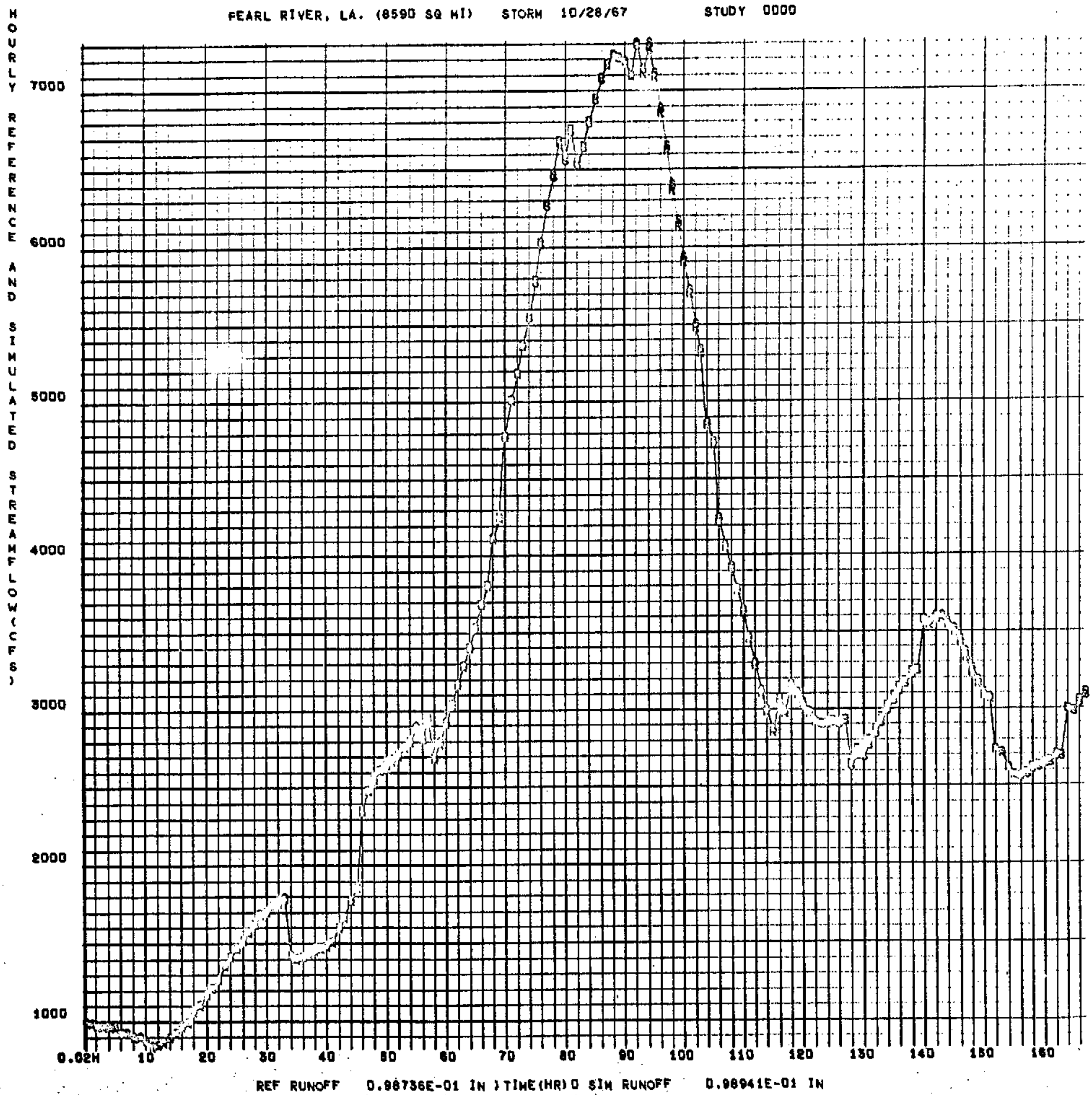
	10/19/67			01/13/68			04/28/68			08/18/68		
SUB WATERSHED 8												
REFERENCE WY 68	2736	98	0.069	35340	121	1.437	15836	168	0.570	1814	122	0.053
SIMULATED	2763	98	0.070	42835	116	1.632	15988	168	0.540	1733	122	0.050

	10/22/67			01/15/68			05/03/68			08/20/68		
SUB WATERSHED 9												
REFERENCE WY 68	2777	86	0.064	36162	133	1.306	17510	119	0.651	2175	135	0.055
SIMULATED	2802	86	0.065	43487	128	1.468	18191	120	0.645	2086	135	0.052

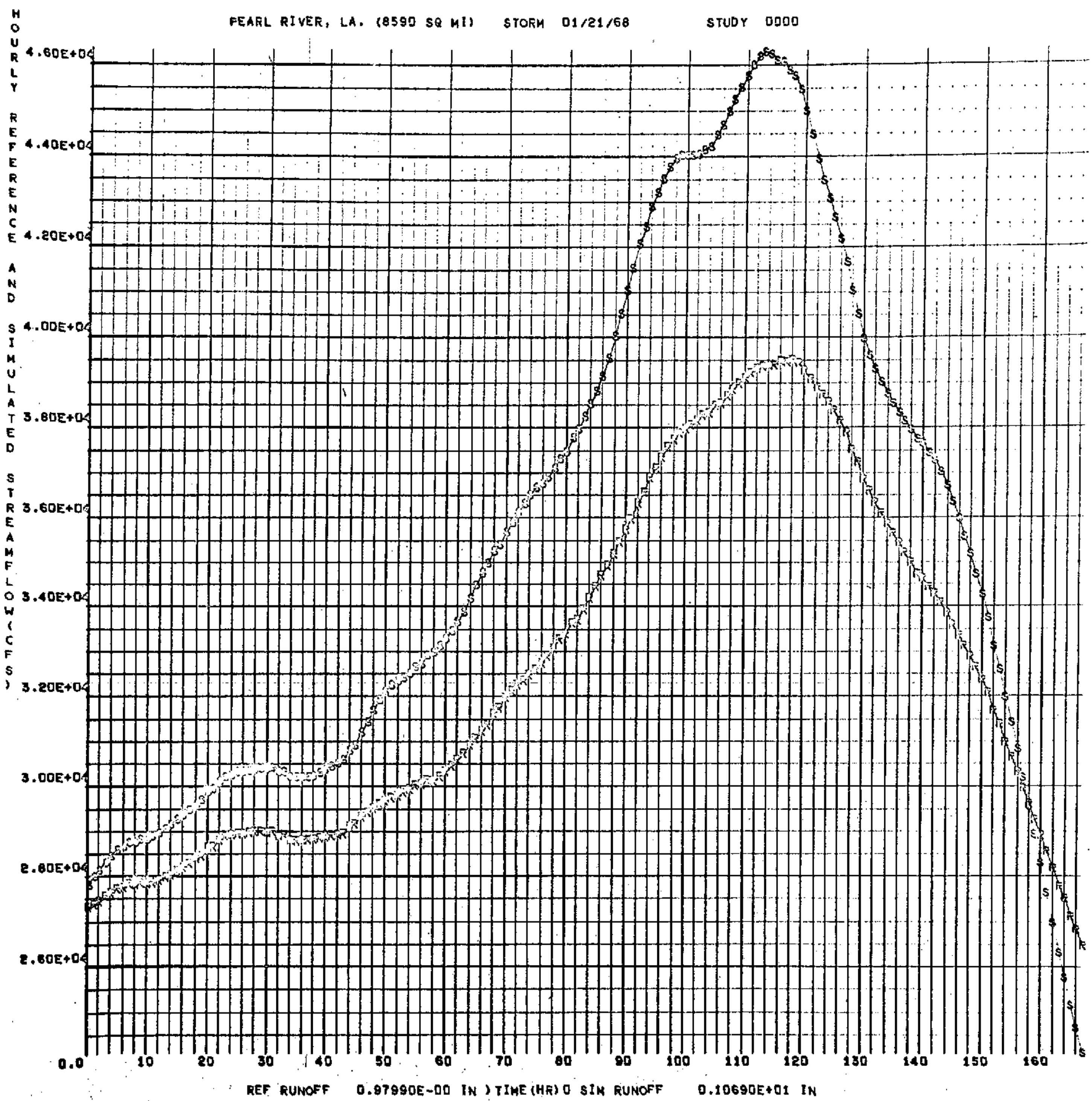
	10/24/67			01/18/68			05/06/68			08/22/68		
SUB WATERSHED 10												
REFERENCE WY 68	2825	108	0.056	37157	131	1.166	18073	117	0.581	2476	138	0.059
SIMULATED	2849	108	0.057	44317	126	1.298	18675	118	0.573	2395	138	0.057

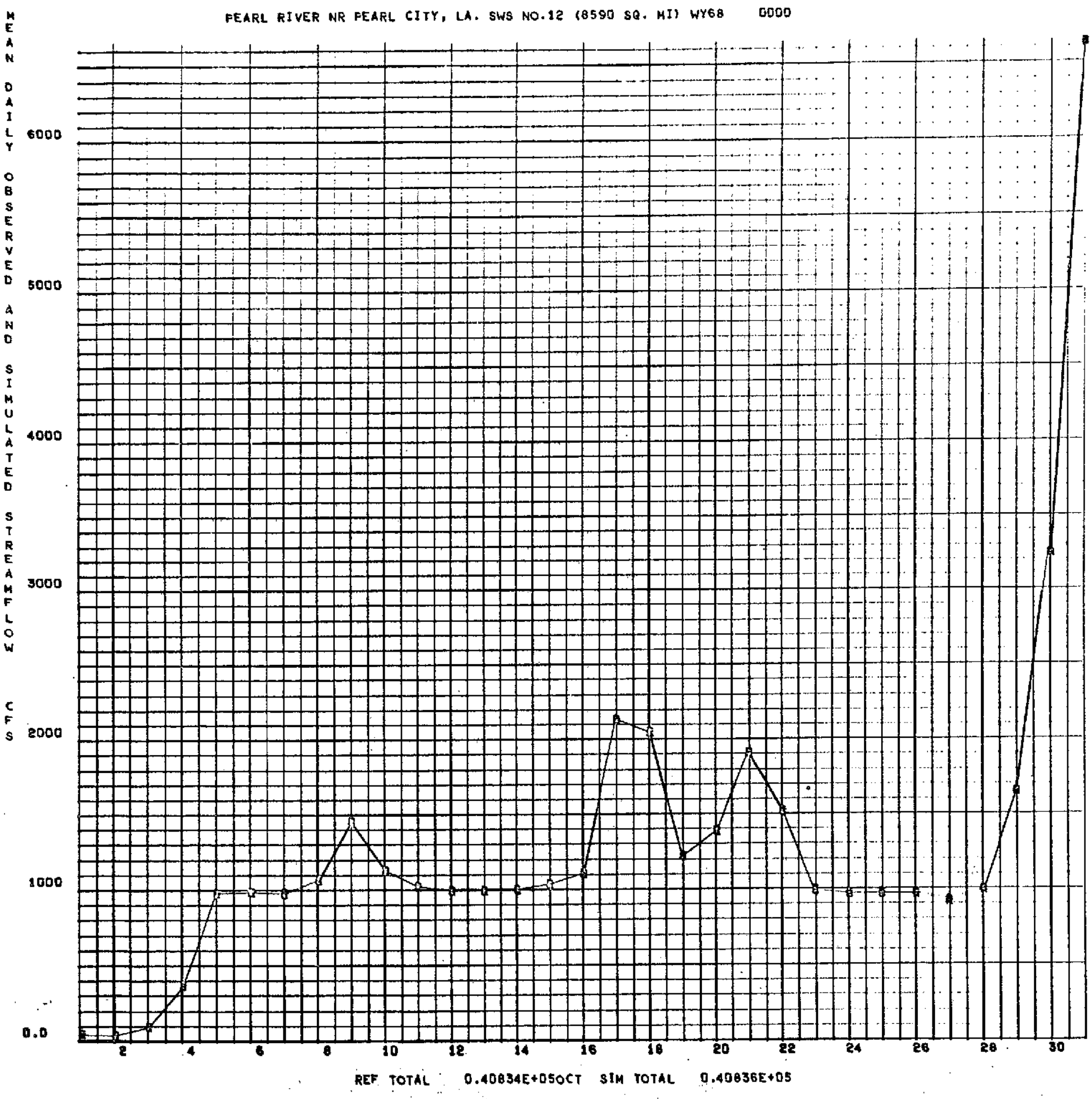
	10/28/67			01/08/68			05/08/68			08/20/68		
SUB WATERSHED 11												
REFERENCE WY 68	1191	95	0.150	5530	104	0.769	4308	122	0.588	363	103	0.031
SIMULATED	1185	95	0.150	6478	96	0.800	4588	122	0.595	357	103	0.030

	10/28/67			01/21/68			05/09/68			08/11/68		
REGIONAL WATERSHED												
REFERENCE WY 68	7298	93	0.099	39521	119	0.980	19567	104	0.487	4166	168	0.064
SIMULATED	7310	95	0.099	46266	114	1.068	19886	104	0.476	4056	168	0.060

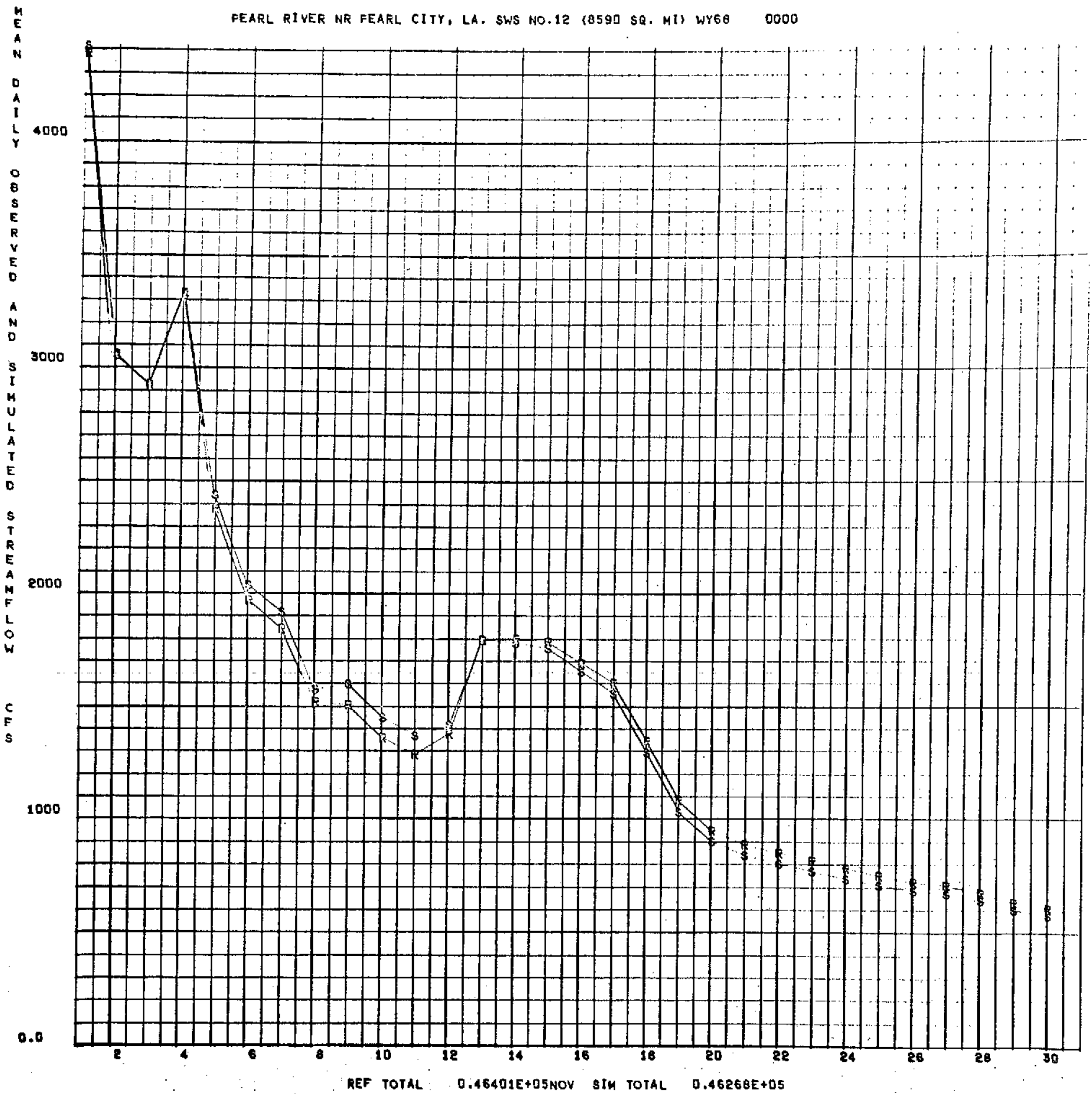


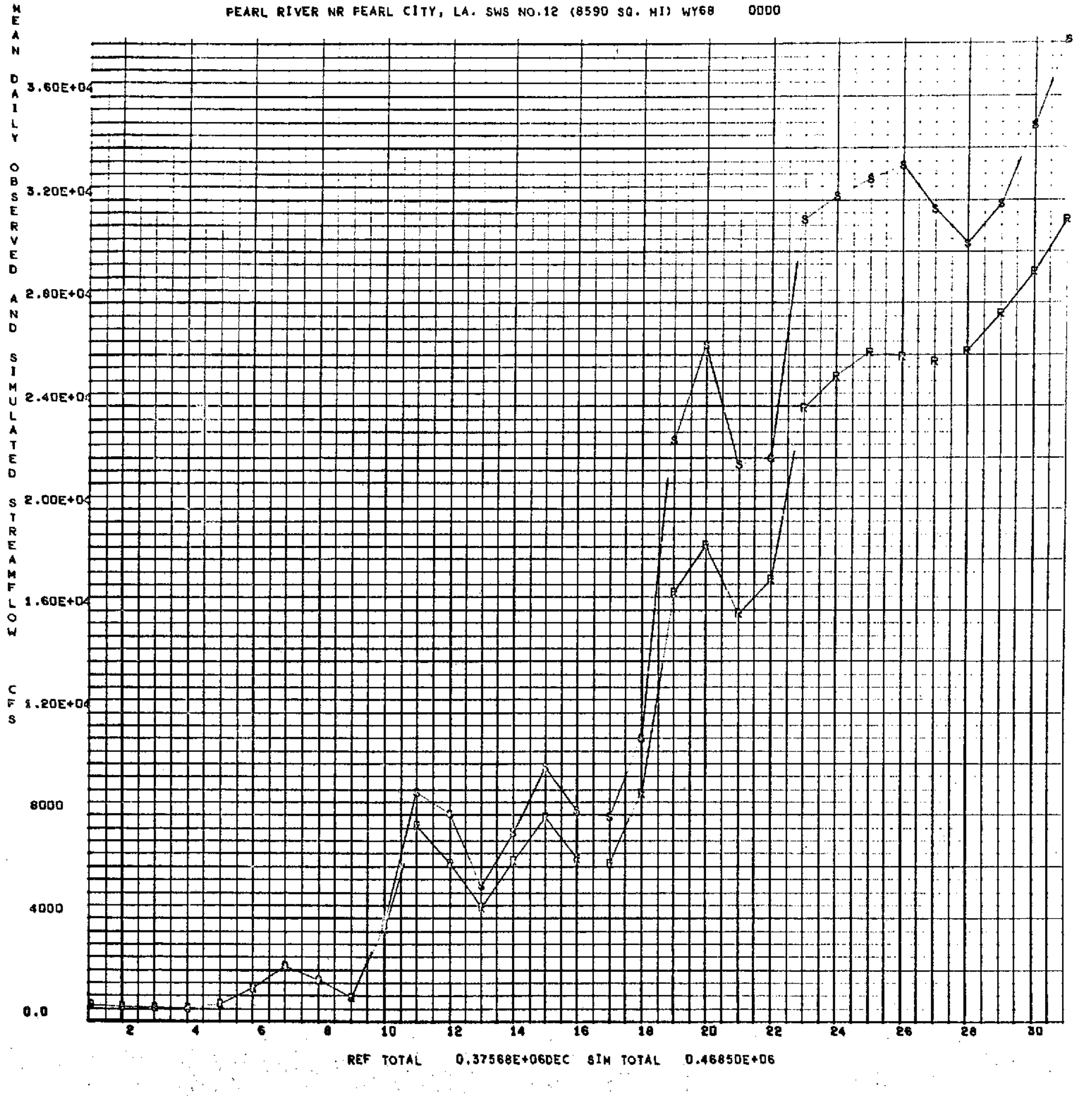
PEARL RIVER, LA. (8590 SQ MI) STORM 10/28/67 STUDY 0000
HOURLY REFERENCE AND SIMULATED STREAMFLOW (CFS)
7000
6000
5000
4000
3000
2000
1000
0.02H
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
REF RUNOFF 0.98736E-01 IN)TIME(HR)0 SIM RUNOFF 0.98941E-01 IN

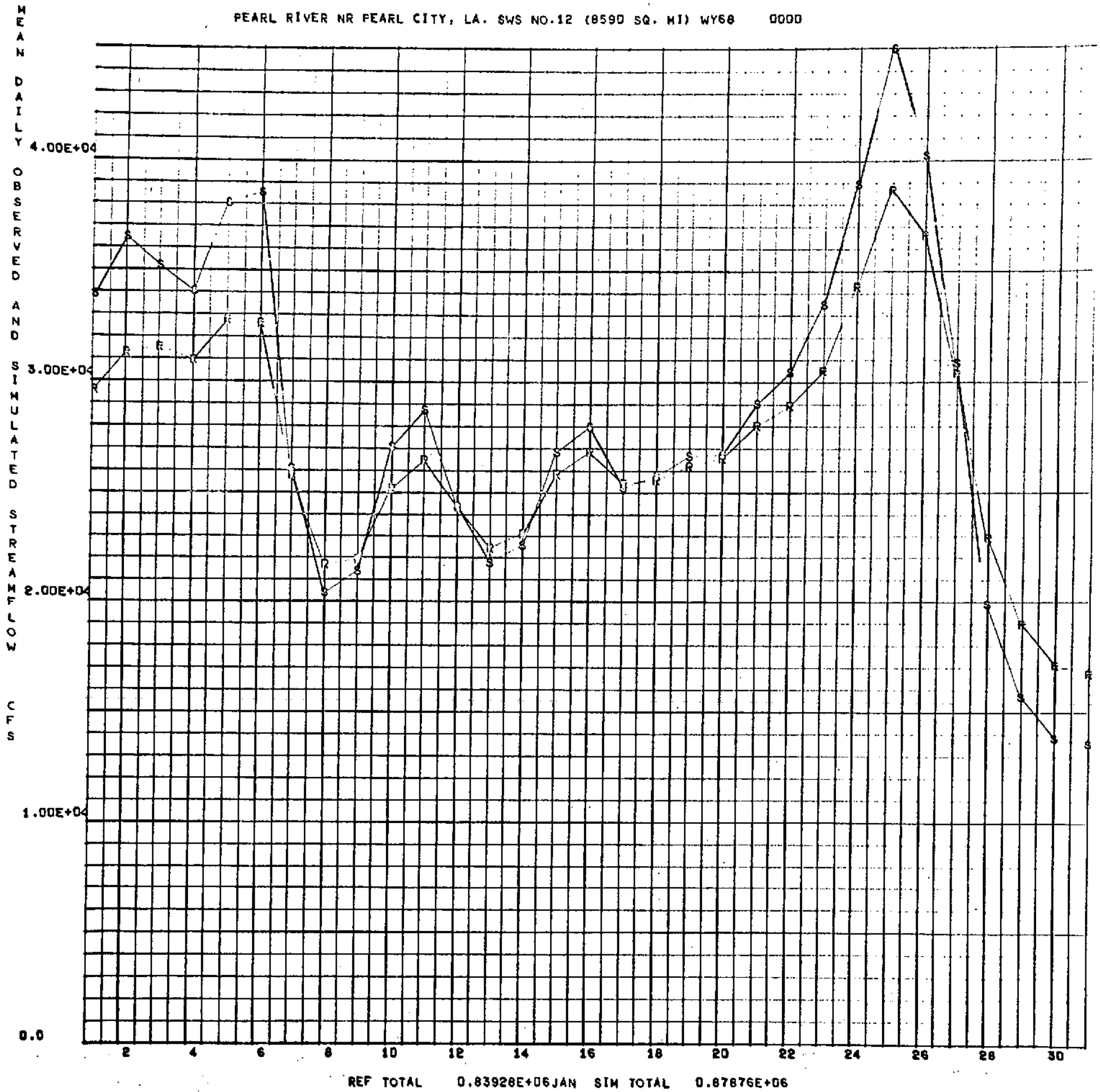

PEARL RIVER, LA. (8590 SQ MI) STORM 01/21/68 STUDY 0000
HOURLY REFERENCE AND SIMULATED STREAMFLOW (CFS)
4.60E+04
4.40E+04
4.20E+04
4.00E+04
3.80E+04
3.60E+04
3.40E+04
3.20E+04
3.00E+04
2.80E+04
2.60E+04
0.0
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
REF RUNOFF 0.97990E-00 IN) TIME (HR) O SIM RUNOFF 0.10690E+01 IN

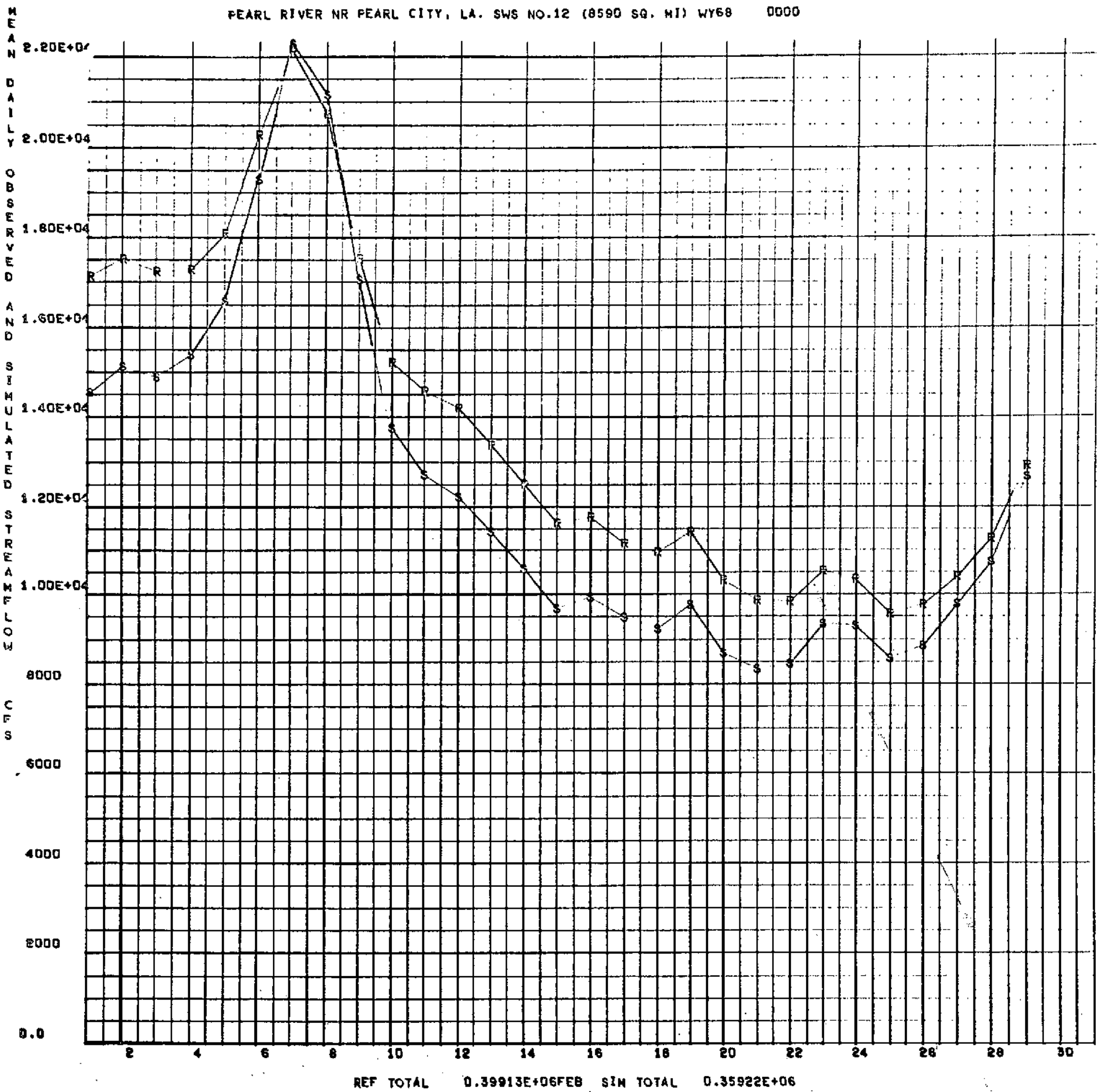


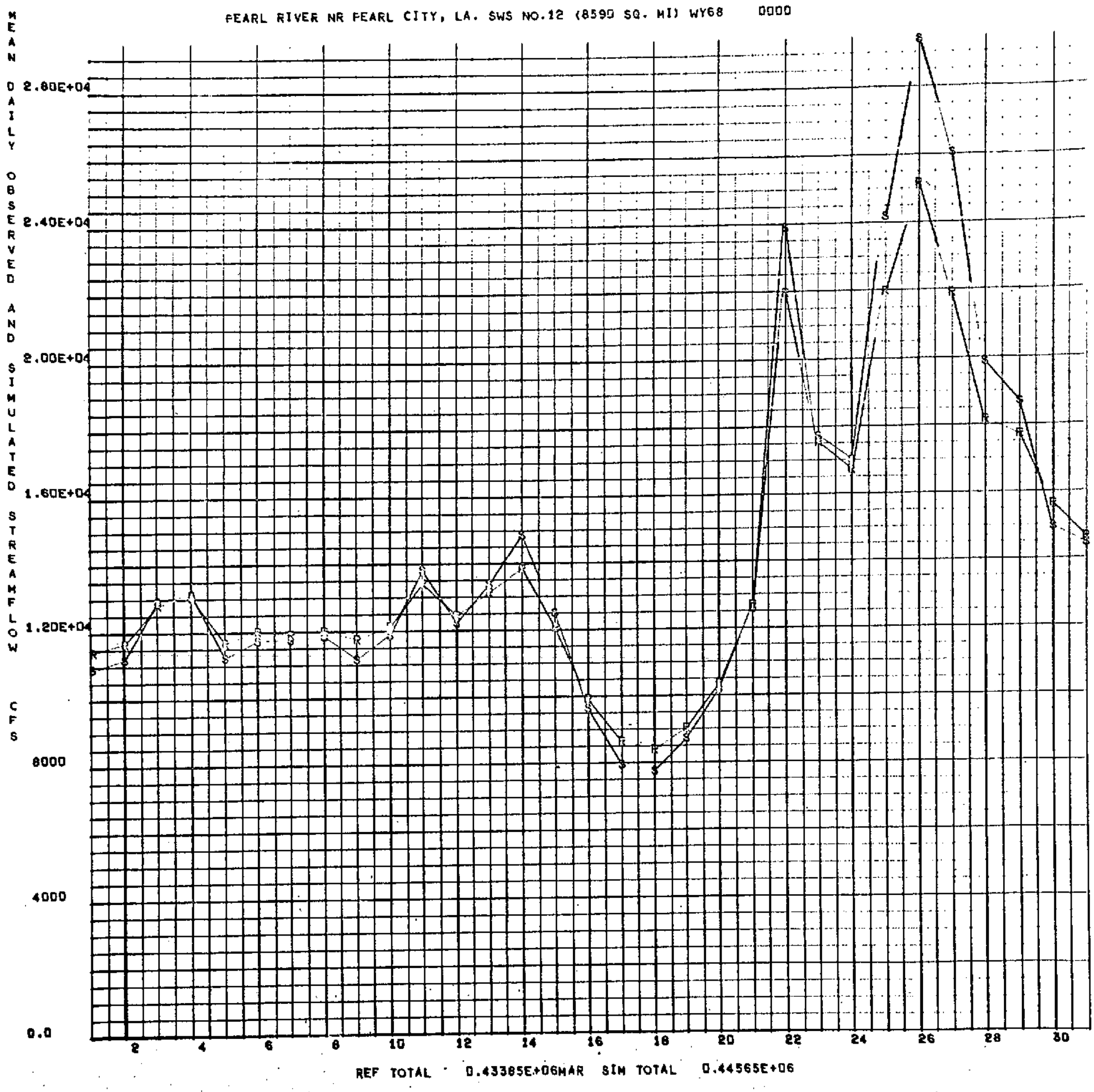
PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
6000
5000
4000
3000
2000
1000
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.40834E+05OCT SIM TOTAL 0.40836E+05


PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
4000
3000
2000
1000
0.0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
REF TOTAL 0.46401E+05NOV SIM TOTAL 0.46268E+05

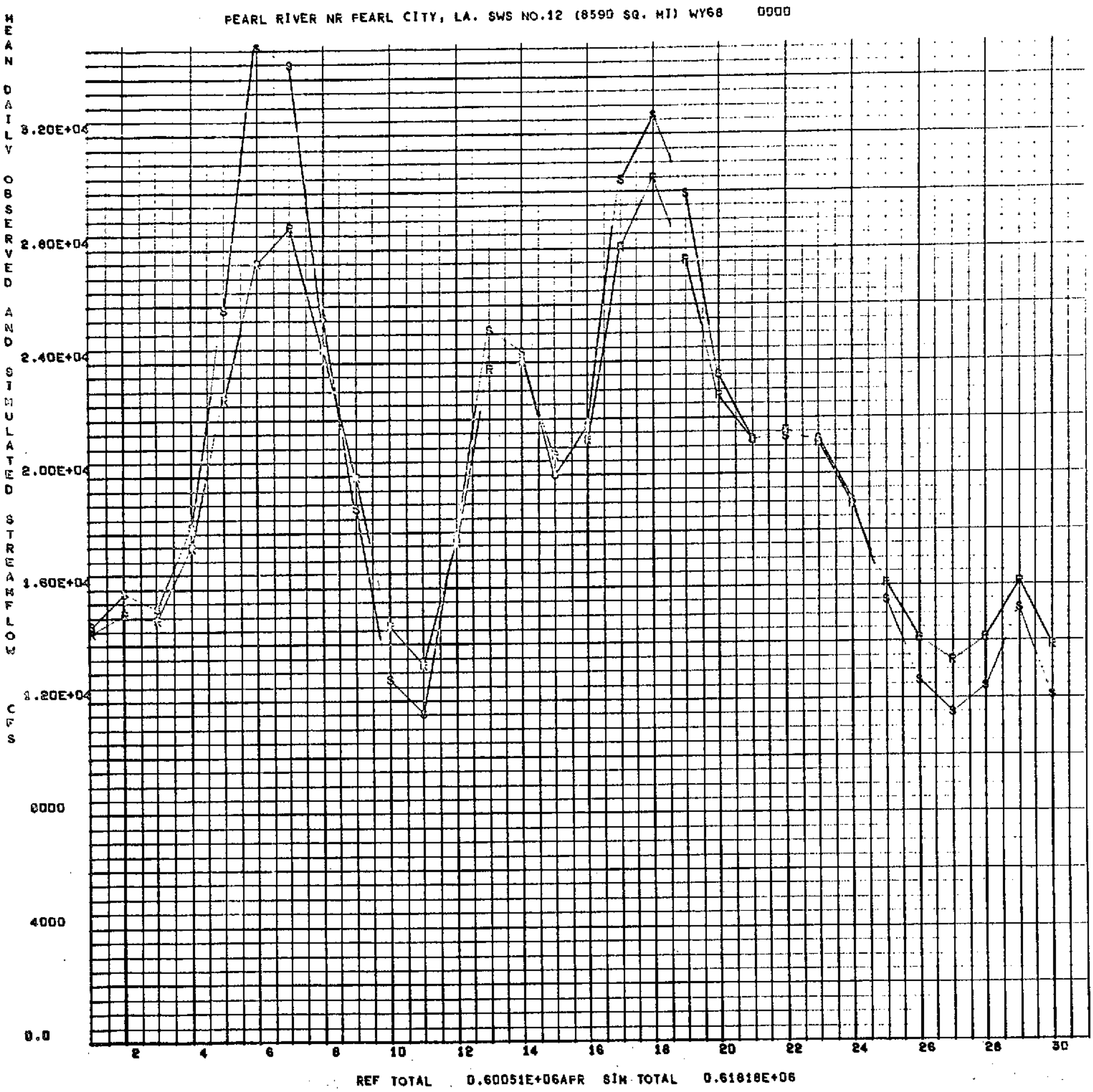

PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
3.60E+04
3.20E+04
2.80E+04
2.40E+04
2.00E+04
1.60E+04
1.20E+04
8000
4000
0.0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
REF TOTAL 0.37568E+06DEC SIM TOTAL 0.46850E+06

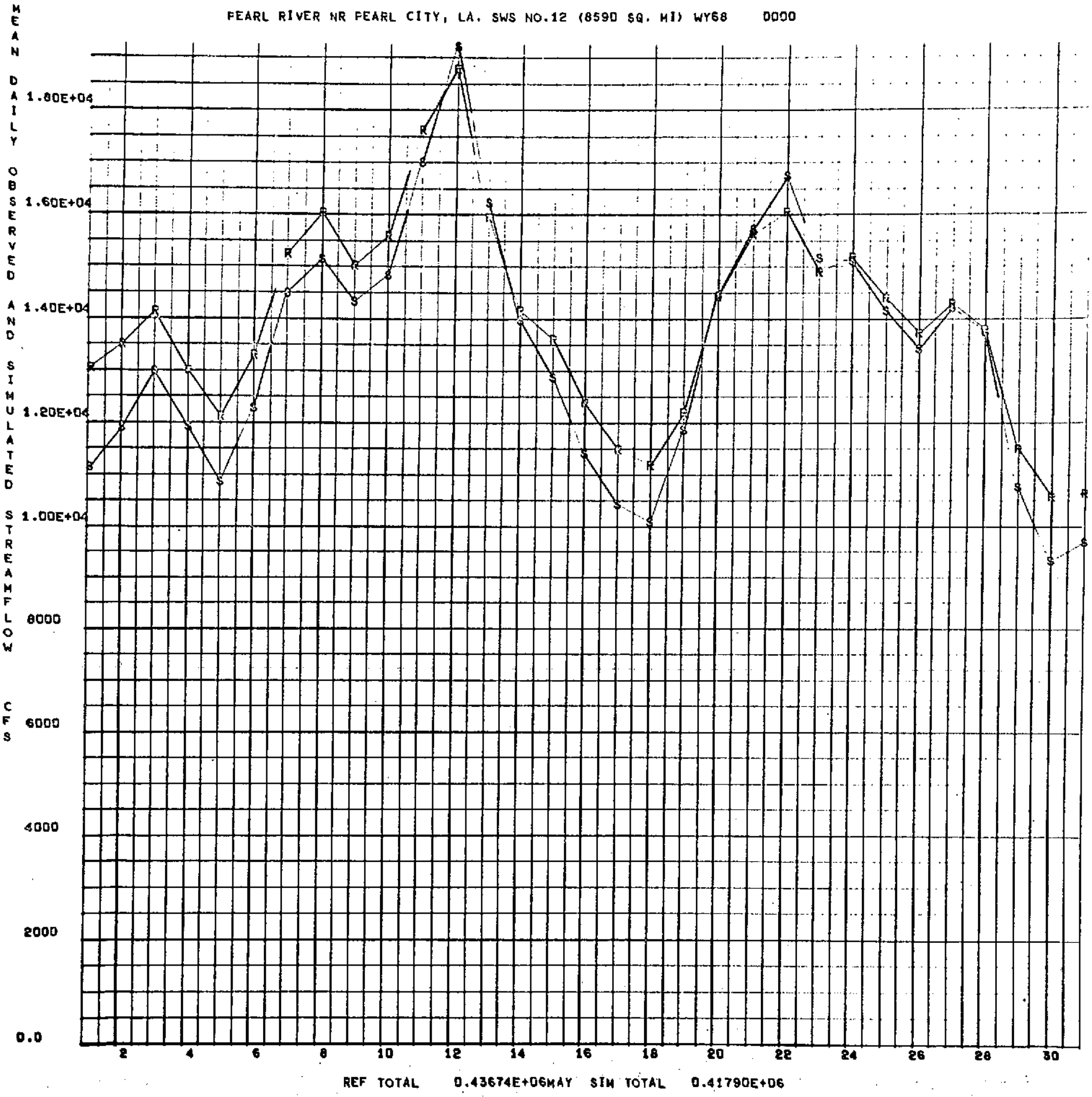

PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
4.00E+04
3.00E+04
2.00E+04
1.00E+04
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.83928E+06JAN SIM TOTAL 0.87876E+06


PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
2.20E+04
2.00E+04
1.80E+04
1.60E+04
1.40E+04
1.20E+04
1.00E+04
8000
6000
4000
2000
0.0
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
REF TOTAL 0.39913E+06FEB SIM TOTAL 0.35922E+06



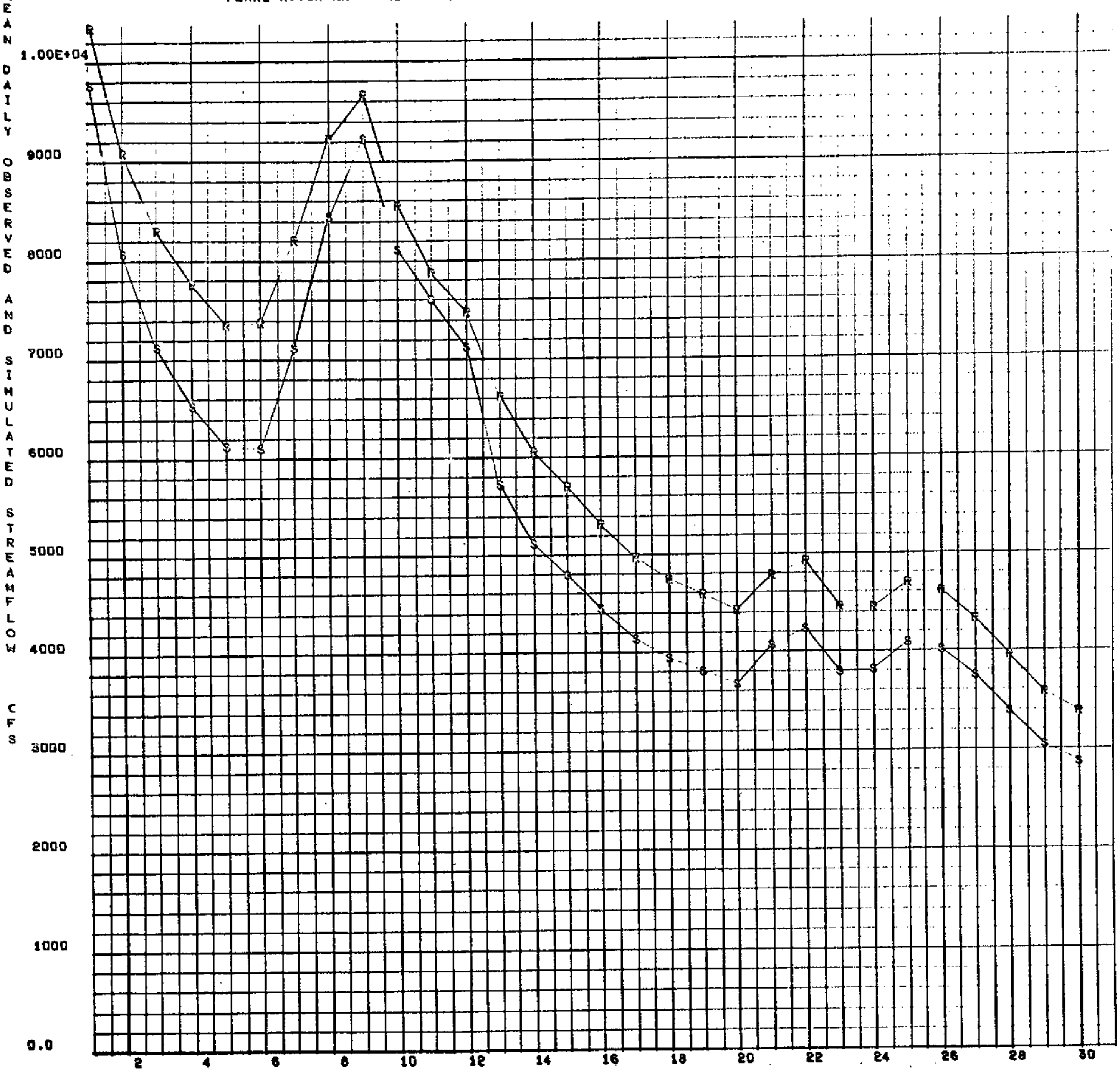
FEARL RIVER NR FEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
2.80E+04
2.40E+04
2.00E+04
1.60E+04
1.20E+04
8000
4000
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.43385E+06MAR SIM TOTAL 0.44565E+06


PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
3.20E+04
2.80E+04
2.40E+04
2.00E+04
1.60E+04
1.20E+04
8000
4000
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.60051E+06APR SIM TOTAL 0.61818E+06

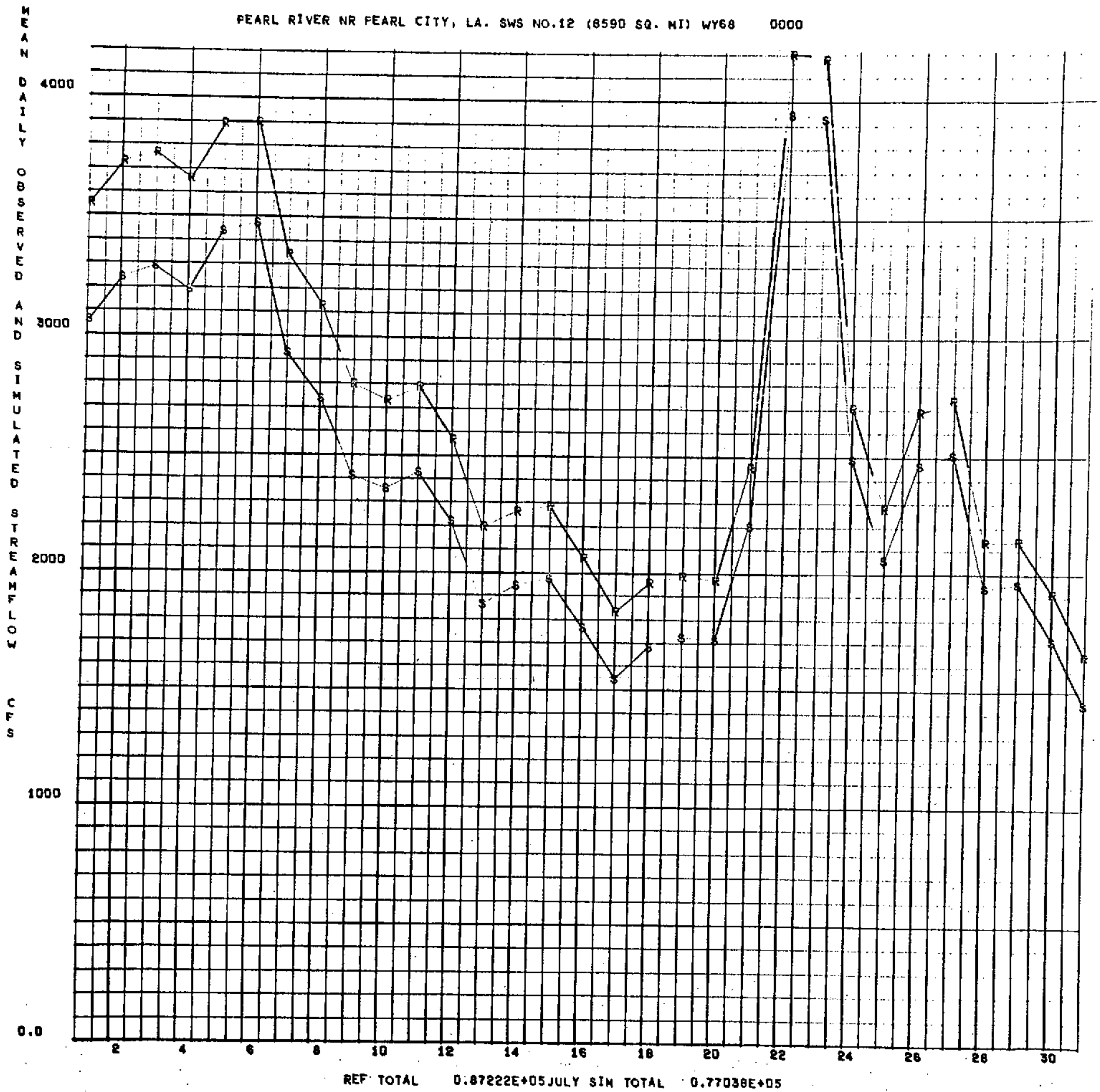


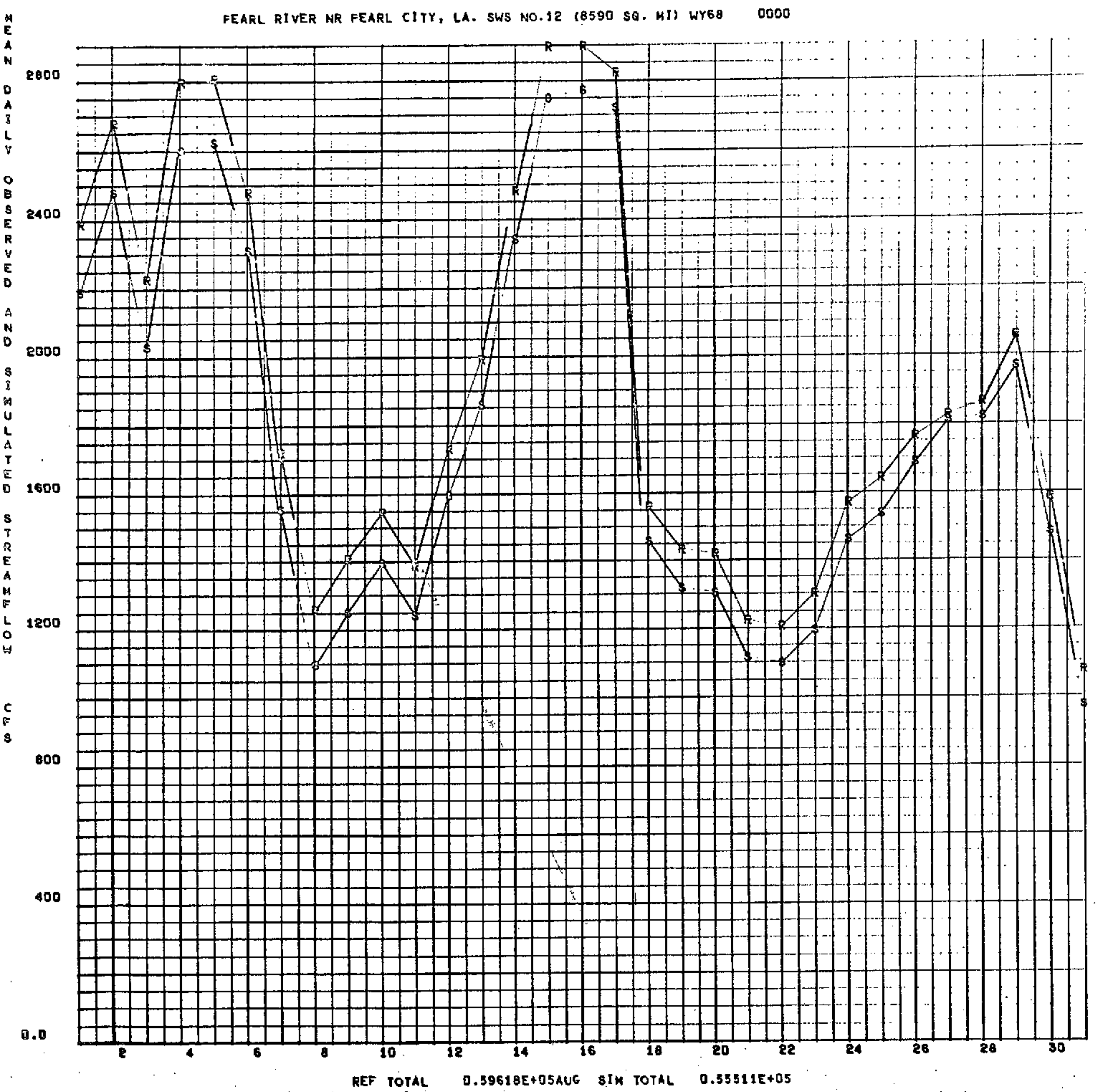
PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
1.80E+04
1.60E+04
1.40E+04
1.20E+04
1.00E+04
8000
6000
4000
2000
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.43674E+06MAY SIM TOTAL 0.41790E+06

FEARL RIVER NR FEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000



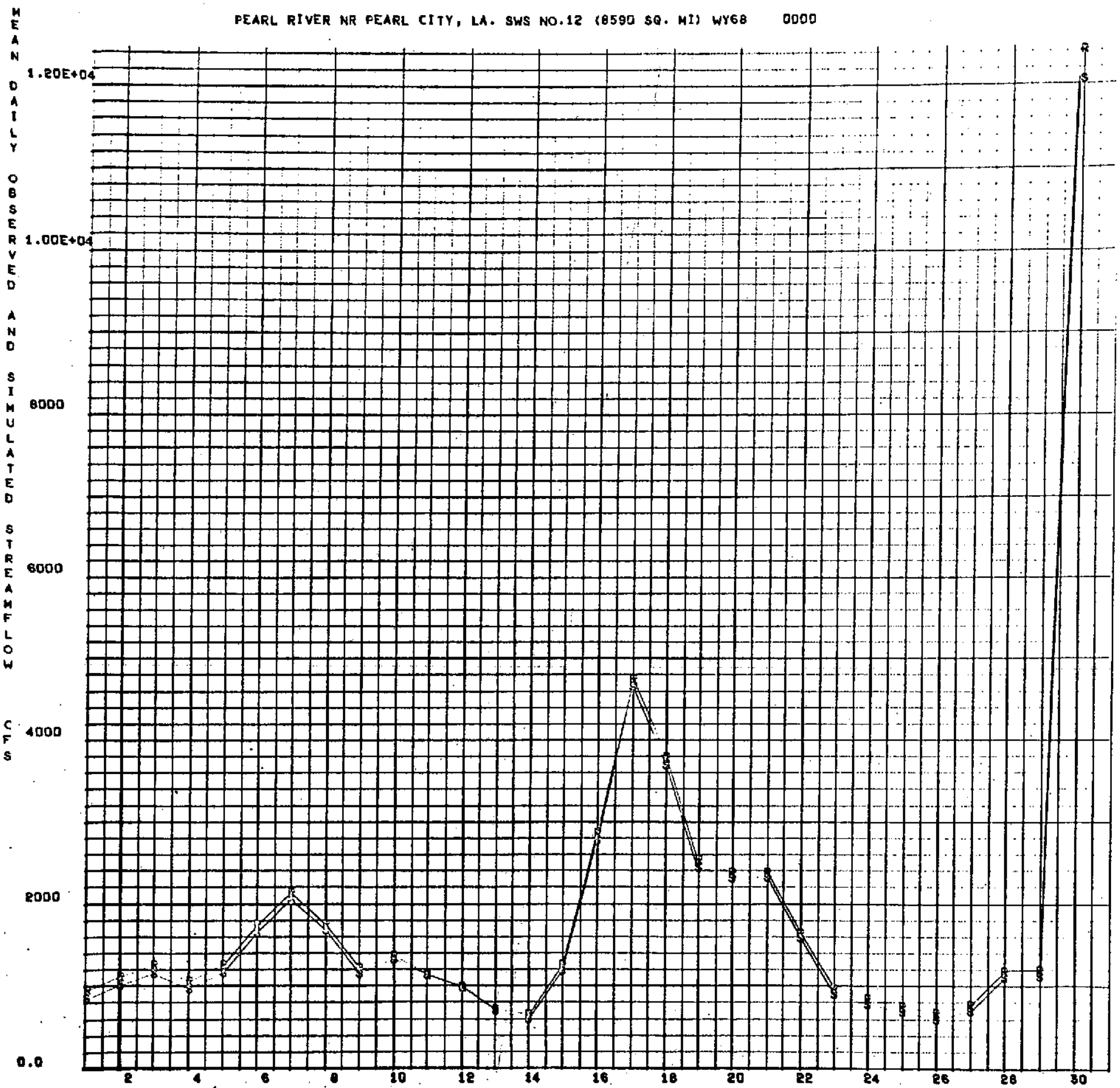
REF TOTAL 0.19394E+06JUNE SIM TOTAL 0.17077E+06


PEARL RIVER NR FEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
4000
3000
2000
1000
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.87222E+05JULY SIM TOTAL 0.77038E+05

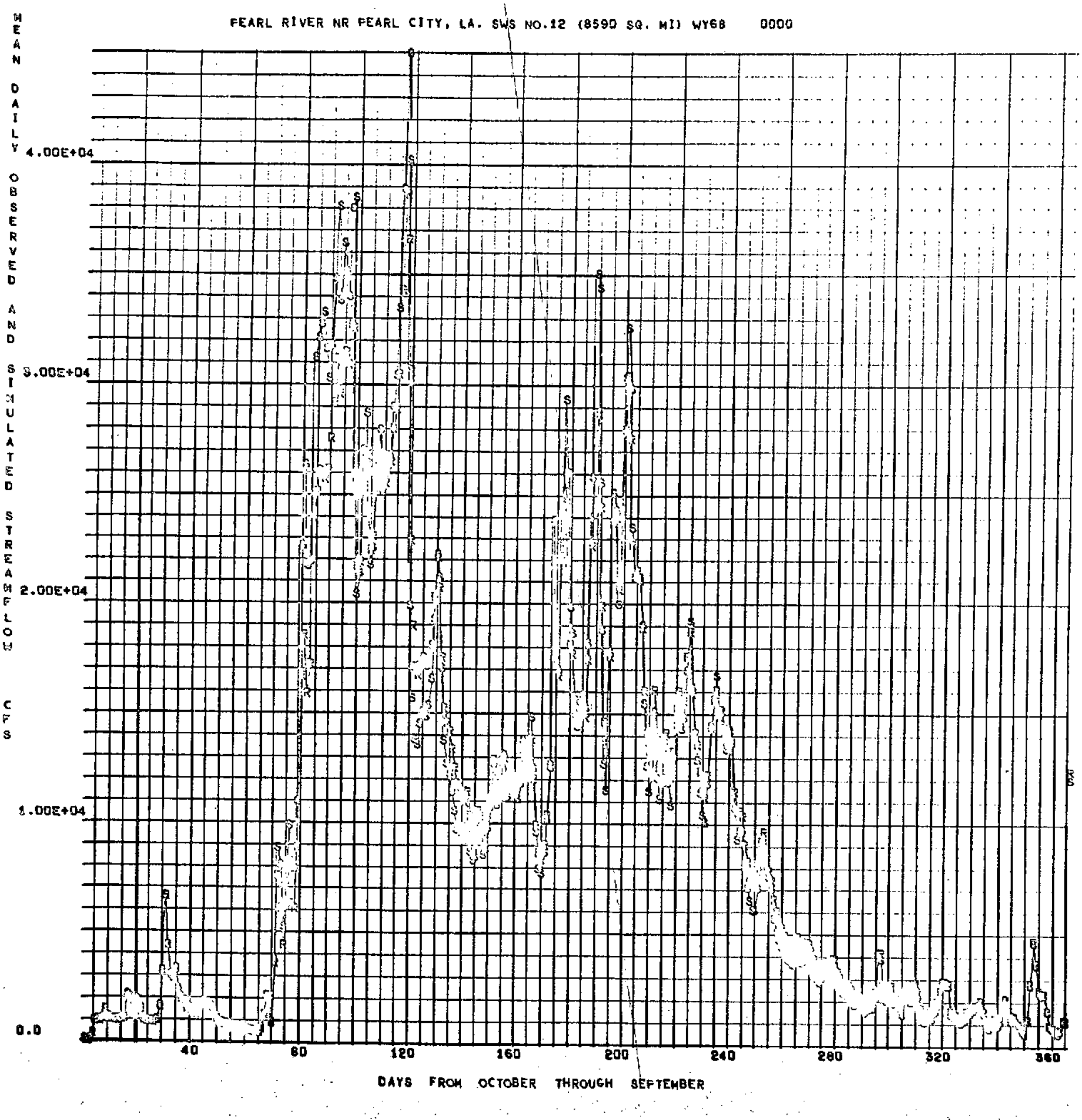


FEARL RIVER NR FEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
2800
2400
2000
1600
1200
800
400
0.0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
REF TOTAL 0.59618E+05AUG SIM TOTAL 0.55511E+05

PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000



REF TOTAL 0.46363E+05SEPT SIM TOTAL 0.44219E+05


PEARL RIVER NR PEARL CITY, LA. SWS NO.12 (8590 SQ. MI) WY68 0000
MEAN DAILY OBSERVED AND SIMULATED STREAMFLOW CFS
4.00E+04
3.00E+04
2.00E+04
1.00E+04
0.0
40
80
120
160
200
240
280
320
360
DAYS FROM OCTOBER THROUGH SEPTEMBER

APPENDIX D

RELATED TECHNICAL ARTICLES AND ABSTRACTS

73W-00-5011

73W 05011. TARGET DETECTION IN AERIAL PHOTOGRAPHY.
AUGUST 1964.
KANAL, LN# RANDALL, NC
PHILCO FORD CORP., BLUE BELL, PA.

11P. THIS PAPER WAS PRESENTED AT WESCON/64. THE AUTOMATIC DETECTION OF TARGETS IN TACTICAL AERIAL PHOTOGRAPHY, REGARDLESS OF WHERE THEY MIGHT APPEAR, IS ACCOMPLISHED VIA A TWO LEVEL STATISTICAL DECISION PROCEDURE WHICH INVOLVES MODIFICATIONS OF CLASSICAL METHODS OF MULTIVARIATE DISCRIMINANT ANALYSIS. COMPUTER SIMULATED TARGET DETECTION EXPERIMENTS PERFORMED ON ACTUAL TACTICAL IMAGERY PRODUCED IMPRESSIVE RESULTS ON INDEPENDENT TEST SAMPLES.

AERIAL PHOTOGRAPHY# TARGET ACQUISITION
COMPUTERIZED SIMULATION# PHOTOINTERPRETATION

73W-00-5012

AIAA-69-1085. THE ROLE OF SATELLITES IN EARTH ECOLOGY.
AIAA 6TH ANNUAL MEETING AND TECHNICAL DISPLAY. ANAHEIM, CALIF. OCTOBER 1969.
CASTRUCCIO, P
IBM GAITHERSBURG, FSD
AIAA-69-1085

MOST OF THE APPLICATIONS OF EARTH OBSERVATION SATELLITES ARE AIMED AT IMPROVED EXPLOITATION OF SPECIFIC NATURAL RESOURCES. IN PRACTICE, THE SPHERE OF INFLUENCE OF TECHNOLOGICAL EXPLOITATION HAS ALREADY REACHED SUCH A SIZE THAT MANY HUMAN ACTIVITIES, ALBEIT IN DIVERSE FIELDS OF ENDEAVOR, ARE BEGINNING TO COUPLE.

ECOLOGY# ARTIFICIAL SATELLITES

73W-00-5014

73W 05014. RECENT PROGRESS IN REMOTE SENSING WITH AUDIO AND RADIO FREQUENCY PULSES. 1964.
GELEYNSE, M# BARRINGER, AR
BARRINGER RESEARCH, LTD., TORONTO, CANADA

26P. THIS PAPER IS FROM THE PROCEEDING OF THE 3RD SYMPOSIUM OF REMOTE SENSING OF ENVIRONMENT, 1964. FURTHER DEVELOPMENT OF THE INPUT OR INDUCED PULSE TRANSIENT ELECTROMAGNETIC SYSTEM HAS RESULTED IN HIGHER POWERED MINIATURIZED EQUIPMENT OF IMPROVED SENSITIVITY. AIRBORNE PROGRAMS IN AUSTRALIA AND THE SOUTHWESTERN UNITED STATES HAVE PROVEN THE CAPABILITIES OF THE SYSTEM FOR DETECTING AND RESOLVING GEOLOGIC FEATURES BENEATH HIGHLY CONDUCTIVE SALINE SOILS. ORE DEPOSITS OF THE PORPHYRY COPPER TYPE HAVE FOR THE FIRST TIME BEEN DETECTED FROM THE AIR IN A COMPREHENSIVE TEST PROGRAM. CONTINUING DEVELOPMENT OF VERY SHORT PULSE VHF RADAR MOUNTED IN A VEHICLE HAS YIELDED NEW INFORMATION ON THE VHF REFLECTIVE PROPERTIES OF SOIL UNDER VARYING CONDITIONS OF LAYERING, MOISTURE CONTENT AND SOIL TYPE. THE FEASIBILITY HAS BEEN ESTABLISHED AND THE PARAMETERS OUTLINED FOR AN AIRBORNE LOW LEVEL TERRAIN SENSING SYSTEM UTILIZING VHF PULSES.

REMOTE SENSING# AIRBORNE DETECTORS# RADAR

73W-00-5015

N69-34879. AN EVALUATION OF CROP AND LAND USE DATA IN A WORLD SAMPLE OF COUNTRIES. NOVEMBER 1968.
BAKER, S.
AGRICULTURE DEPT., WASHINGTON, D.C.
N69-34879# NASA-CR-103944

25P. THE MAIN OBJECTIVE OF THIS STUDY WAS TO PROVIDE INFORMATION USEFUL IN DETERMINING HOW, AND TO WHAT EXTENT, REMOTE SENSING MIGHT HELP IN SUPPLYING MORE ACCURATE, COMPREHENSIVE, AND TIMELY DATA ON CROP AREAS, CROP YIELDS, CROP PRODUCTION, AND LAND USE AROUND THE WORLD. REMOTE SENSING IS THE METHOD USED TO COLLECT SUCH DATA ABOUT THE EARTH'S SURFACE. THIS METHOD UTILIZED OPTICAL, ELECTROOPTICAL, AND ELECTRONIC DEVICES MOUNTED IN AIRPLANES OR SATELLITES. REMOTE SENSING PROMISES TO CLOSE SOME OF THE REMAINING GAPS IN AVAILABLE DATA, AND TO IMPROVE DATA QUALITY AND TIMELINESS. IT MAY BE POSSIBLE, THROUGH REMOTE SENSING, TO REPLACE SOME PRESENT METHODS WITH LESS COSTLY METHODS.

REMOTE SENSING# LAND USE# AIRBORNE DETECTORS

73W-00-5028

N70-38529. REPORTS, STUDIES, AND INVESTIGATIONS RELATING TO SATELLITE HYDROLOGY: ANNOTATED BIBLIOGRAPHY. JUNE 1970.
BAKER, DR# FLANDERS, AF# FLEMING, M
COMMERCE DEPT.
N70-38529# ESSA-TM-NESCTM-10# PB194072

30P. PRESENTED IS AN ANNOTATED BIBLIOGRAPHY FOR A SATELLITE HYDROLOGY PROGRAM. THE OBJECTIVE OF THIS PROGRAM IS TO DEVELOP HYDROLOGIC PROBLEMS FROM SATELLITE INVESTIGATIONS, REPORTS, AND STUDIES.

HYDROLOGY# ARTIFICIAL SATELLITES# METEOROLOGY
HYDROMETEOROLOGY# BIBLIOGRAPHIES

73W-00-5029

73W 05029. SIMULATION OF HEAT TRANSFER IN SOILS. JULY 1970.
WIERENGA, PJ
NEW MEXICO STATE UNIV., LAS CRUCES
DEWIT, CT
AGRICULTURAL UNIV., WAGENINGEN, NETHERLANDS

8P. THIS PAPER IS FROM THE PROCEEDINGS OF THE SOIL SCIENCE SOCIETY OF AMERICA, VOL. 34,1970. A COMPUTER MODEL WAS DEVELOPED TO PREDICT THE TEMPERATURE FLUCTUATION IN SUBSOIL FROM THE TEMPERATURE VARIATION AT THE SOIL SURFACE, TAKING INTO ACCOUNT CHANGES IN THE APPARENT THERMAL CONDUCTIVITY WITH DEPTH BELOW SOIL SURFACE AND SOIL TEMPERATURE. THE MODEL MAKES USE OF S/360 CSMP, A RECENTLY DEVELOPED SIMULATION LANGUAGE FOR DIGITAL COMPUTERS. PREDICTED SOIL TEMPERATURES WERE COMPARED WITH SOIL TEMPERATURES OBSERVED AT 2, 10, 15, 25, 30, AND 75 CM BELOW THE SURFACE OF BARE FIELD PROFILES, BEFORE AND AFTER IRRIGATION WITH 13.4 CM WATER. IN WET SOIL OBSERVED AND PREDICTED TEMPERATURES WERE IN CLOSE AGREEMENT. IN DRY SOIL SIGNIFICANT DIFFERENCES WERE OBSERVED BETWEEN MEASURED AND PREDICTED SOIL TEMPERATURES DURING PART OF THE DAY. THE INCREASE IN APPARENT THERMAL CONDUCTIVITY WITH SOIL TEMPERATURE HAD A NEGATIVE EFFECT ON THE MAGNITUDE OF THE DIFFERENCE BETWEEN OBSERVED AND PREDICTED VALUES IN THE DRY SOIL. AGREEMENT WAS FOUND BETWEEN SOIL HEAT FLUX DENSITY VALUES PREDICTED FROM THE MODEL AND CALCULATED WITH THE TEMPERATURE INTEGRAL METHOD. USE OF A DIGITAL SIMULATION LANGUAGE CAN SAVE CONSIDERABLE PROGRAMMING TIME, AND CAN BE APPLIED TO MOVEMENT OF WATER AND GASES IN SOIL PROFILES.

SOIL PROFILES# THERMAL CONDUCTIVITY
HEAT TRANSFER# DIGITAL SIMULATION# IBM SYSTEM/ 360

73W-00-5031

N70-41150. A PRELIMINARY EVALUATION OF AIRBORNE AND SPACEBORNE REMOTE SENSING DATA FOR HYDROLOGIC USES.
JULY 1966.
ROBINOVE, CJ
GEOLOGICAL SURVEY, WASHINGTON, D.C.
N70-41150# NASA-CR-76594# TL-NASA-50

19P. REMOTE SENSORS ARE EXAMINED AS VALUABLE TOOLS FOR OBTAINING WATER RESOURCE DATA ON OCCURRENCE, MOVEMENT, AND INTERACTIONS OF WATER, AND AS A BASIS FOR CONTROL. TABULATED DATA PRESENT A BRIEF EVALUATION OF AIRBORNE AND SPACEBORNE REMOTE SENSORS USED IN HYDROLOGY. LIMITED USE OF SENSORS IS DEFINED IN THE AREAS OF MEASURING PHYSICAL, CHEMICAL, AND BIOLOGICAL CHARACTERISTICS OF WATER SURFACES, MAPPING AND DESCRIBING GROUND WATER FEATURES, SNOW SURVEYING AND MAPPING, GLACIOLOGY, GEOMORPHOLOGY, AND MEASURING LIQUID VAPOR TRANSFER.

REMOTE SENSING# HYDROLOGY# WATER RESOURCES

73W-00-5034

REF. NO. 70-13. CRUISE REPORT - CHAIN CRUISE 92.
MARCH 1970.
GIFFORD, J
WOODS HOLE OCEANOGRAPHIC INSTITUTION, MASS.
REF. NO. 70-13# N00014-66-C-0241

29P. CRUISE 92 DEPARTED WOODS HOLE ON THE 10TH OF JUNE, 1969. A TOTAL OF NINE MOORINGS WERE SET, TWO OF WHICH WERE TEMPORARY, (A SHORT TERM ENGINEERING MOORING AND THE GLASS FLOAT TEST). ONE LONG TERM, (SIX MONTH) SYNTACTIC FOAM FLOAT NEAR BOTTOM MOORING WAS RETRIEVED. OTHER WORK INCLUDED HYDROSTATIONS, XBT'S, CURRENT PROFILE MEASUREMENTS IN CONJUNCTION WITH THE HYDROSTATIONS, AND RADAR TRANSPONDER TESTS.

MOORINGS# TRANSPONDERS# BUOYS

73W-00-5036

73W 05036. ORBITAL PHOTOGRAPHY: APPLIED EARTH SURVEY TOOL. 1968.
WOBBER, FJ
IBM GAITHERSBURG, FSD

9P. ORBITAL PHOTOGRAPHS MAY BE DEFINED AS IMAGES OF PLANETARY SURFACES TAKEN FROM AN ORBITAL POINT OF OBSERVATION, AND MAY BE GENERALLY CONSIDERED AN EXTENSION OF AERIAL PHOTOGRAPHY TO EXTREME ALTITUDES. AS DEFINED HERE, ORBITAL PHOTOGRAPHY IS LIMITED TO SURVEY'S OF THE EARTH'S SURFACE.

SPACEBORNE PHOTOGRAPHY# PHOTOGRAMMETRY# SURVEYS

73W-00-5041

73W 05041. A MODEL OF WATER QUALITY MANAGEMENT UNDER UNCERTAINTY.
WATER RESOURCES RESEARCH. JUNE 1970. P690-699.
UPTON, C
CHICAGO UNIV., ILL.

THE PROBLEMS CAUSED BY INTRODUCING UNCERTAINTY INTO THE ANALYSIS OF WATER QUALITY MANAGEMENT IS ANALYZED IN THIS PAPER. THE FIRST SECTION OF THIS PAPER CONTAINS A DISCUSSION OF THE COST FUNCTIONS, THE STOCHASTIC PROPERTIES OF STREAMFLOW, AND THE OBJECTIVE FUNCTION TO BE USED IN THE MODEL. THE MODEL IS ANALYZED IN THE SECOND SECTION. AN EXAMPLE IS PRESENTED IN THE THIRD SECTION, AND SUMMARY REMARKS ARE CONTAINED IN THE FOURTH.

WATER QUALITY# STREAM FLOW# STOCHASTIC PROCESSES

73W-00-5042

73W 05042. STOCHASTIC MODELS IN HYDROLOGY.
WATER RESOURCES RESEARCH. JUNE 1970. P750-755.
SCHEIDEGGER, AE
GEOLOGICAL SURVEY, URBANA, ILL.

THE STOCHASTIC MODELS THAT CAN BE USED TO REPRESENT GROWTH AND STEADY STATE PHENOMENA IN HYDROLOGY ARE REVIEWED.

HYDROLOGY# STOCHASTIC PROCESSES# STEADY STATE

73W-00-5043

73W 05043. A TWO STEP PROBABILISTIC MODEL OF STORAGE RESERVOIR WITH CORRELATED INPUTS.
WATER RESOURCES RESEARCH. JUNE 1970. P756-767.
KLEMES, V
TORONTO UNIV., ONTARIO

FRAGMENTATION OF MORAN'S MODEL AND DECOMPOSITION OF ITS TRANSITION MATRIX INTO A RELEASE RULE AND AN INPUT COMPONENT ARE USED TO SIMPLIFY THE PROBLEM FORMULATION FOR RESERVOIRS WITH COMPLEX OPERATING RULES AND TO DERIVE THE LLOYD MODEL DIRECTLY FROM THAT OF MORAN BY INTRODUCING TWO SUCCESSIVE TRANSITIONS OF ONE VARIABLE INSTEAD OF A SINGLE BIVARIATE TRANSITION.

PROBABILITY THEORY# RESERVOIRS# TRANSITION PROBABILITIES

73W-00-5044

73W 05044. DIGITAL ANALYSIS OF AREAL FLOW IN MULTIAQUIFER GROUNDWATER SYSTEMS: A QUASI THREE DIMENSIONAL MODEL.
WATER RESOURCES RESEARCH. JUNE 1970. P883-888.
BREDEHOEFT, JD# PINDER, GF
GEOLOGICAL SURVEY, WASHINGTON, D.C.

A GENERAL SOLUTION FOR THE RESPONSE OF MULTIPLE AQUIFER SYSTEMS TO PUMPING STRESS REQUIRES SOLVING THE THREE DIMENSIONAL FLOW EQUATIONS.

AQUIFERS# GROUND WATER# THREE DIMENSIONAL FLOW

73W-00-5045

73W 05045. NUMERICAL MODELING OF UNSATURATED GROUNDWATER FLOW AND COMPARISON OF THE MODEL TO A FIELD EXPERIMENT.
WATER RESOURCES RESEARCH. JUNE 1970. P862-874.
GREEN, DW# DABIRI, H# WEINAUG, CF
KANSAS UNIV., LAWRENCE
PRILL, R
GEOLOGICAL SURVEY, GARDEN CITY, KANS.

A MATHEMATICAL MODEL DESCRIBING ISOTHERMAL, TWO PHASE FLOW IN POROUS MEDIA HAS BEEN DEVELOPED.

GROUND WATER# MATHEMATICAL MODELS# SOIL WATER

73W-00-5047

73W 05047. LEAST SQUARES ESTIMATION OF CONSTANTS IN A LINEAR RECESSION MODEL.
WATER RESOURCES RESEARCH. AUGUST 1970. P1062-1069.
JAMES, LD# THOMPSON, WO
KENTUCKY UNIV., LEXINGTON

LEAST SQUARES CAN BE USED FOR ESTIMATING CONSTANTS IN A LINEAR RECESSION MODEL FROM PUBLISHED AVERAGE DAILY STREAMFLOWS. A MODEL WITH TWO RECESSION CONSTANTS WAS DERIVED AND SUCCESSFULLY TESTED ON A NUMBER OF KENTUCKY STREAMS.

LEAST SQUARES METHOD# STREAM FLOW# HYDROLOGY

73W-00-5048

73W 05048. APPLICATION OF LINEAR RANDOM MODELS TO FOUR ANNUAL STREAMFLOW SERIES.
WATER RESOURCES RESEARCH. AUGUST 1970. P1070-1078.
CARLSON, RF
ALASKA UNIV., COLLEGE
MACCORMICK, AJ# WATTS, DG
WISCONSIN UNIV., MADISON

A SIMPLE METHOD FOR DESCRIBING RANDOM TIME SERIES IS ILLUSTRATED BY APPLICATION TO THE ANNUAL STREAMFLOW DATA OF THE ST. LAWRENCE, THE MISSOURI, THE NEVA, AND THE NIGER RIVERS.

STREAM FLOW# RANDOM PROCESSES# TIME SERIES ANALYSIS

73W-00-5049

73W 05049. A CRITIQUE OF METHODS SIMULATING RAINFALL.
WATER RESOURCES RESEARCH. AUGUST 1970. P1104-1114.
HALL, MJ
IMPERIAL COLLEGE OF SCIENCE AND TECH., LONDON, ENGLAND

THREE FUNDAMENTAL PROBLEMS ARE ENCOUNTERED IN DESIGNING A RAINFALL SIMULATOR: (1) THE CONTROL OF APPLICATION RATES IN BOTH SPACE AND TIME, (2) THE REPRODUCTION OF DROP SIZE DISTRIBUTIONS OBSERVED IN DIFFERENT INTENSITIES OF NATURAL RAINFALL AT THE CORRESPONDING APPLICATION RATES, (3) THE REPRODUCTION OF THE TERMINAL VELOCITIES OF DROPS IN NATURAL RAINFALL.

RAINFALL# SIMULATION# RAINDROPS

73W-00-5050

73W 05050. NONLINEAR TIME VARYING MODEL OF RAINFALL RUNOFF RELATION.
WATER RESOURCES RESEARCH. OCTOBER 1970. P1277-1286.
CHIU, CL# HUANG, JT
PITTSBURGH UNIV., PA.

THE DEVELOPED NONLINEAR TIME VARYING MODEL OF A HYDROLOGIC SYSTEM THAT RELATES THE RAINFALL AND THE RUNOFF IS REPRESENTED BY A PAIR OF NONLINEAR ORDINARY DIFFERENTIAL EQUATIONS WITH TIME VARYING COEFFICIENTS. THE MODEL DOES NOT REQUIRE THE LINEARITY AND TIME INVARIANCE ASSUMPTIONS NECESSARY IN CONVENTIONAL UNIT HYDROGRAPH METHODS.

RAINFALL# RUNOFF# NONLINEAR SYSTEMS

73W-00-5051

73W 05051. MODELING THE EFFECT OF LAND USE MODIFICATIONS ON RUNOFF.
WATER RESOURCES RESEARCH. OCTOBER 1970. P1287-1295.
ONSTAD, CA
AGRICULTURE DEPT., BROOKINGS, S. DAK.
JAMIESON, DG
WATER RESOURCES BOARD, READING, ENGLAND.

THE USE OF MATHEMATICAL MODELS FOR SIMULATING THE RESPONSE CHARACTERISTICS OF A WATERSHED HAS BEEN FIRMLY ESTABLISHED. THESE MODELS CAN BE USED FOR GENERATING A LONGER PERIOD OF FLOW RECORDS FROM A SHORTER RECORD, PROVIDED LONGTERM RAINFALL RECORDS ARE AVAILABLE. IN ADDITION, SOME FLOW SIMULATION MODELS ARE SUITABLE FOR REAL TIME FORECASTING. THE MAJOR PROBLEM IS DEFINING THE PARAMETERS OF A PARTICULAR WATERSHED TO CONVERT THE GENERAL MODEL INTO THE SPECIFIC.

RUNOFF# MATHEMATICAL MODELS# WATERSHEDS

73W-00-5052

73W 05052. PREDICTING AND MAPPING THE AVERAGE HYDROLOGIC RESPONSE FOR THE EASTERN UNITED STATES.
WATER RESOURCES RESEARCH. OCTOBER 1970. P1312-1326.
WOODRUFF, JF# HEWLETT, JD
GEORGIA UNIV., ATHENS

AN ATTEMPT WAS MADE TO PREDICT THE AVERAGE ANNUAL HYDROLOGIC RESPONSE (RATION OF ANNUAL DIRECT RUNOFF TO ANNUAL PRECIPITATION) OF UNGAGED WATERSHEDS IN THE EAST BY REGRESSION AGAINST 15 PLANIMETRIC, HYPSOMETRIC, AND LAND USE FACTORS AVAILABLE ON 90 SELECTED TEST BASINS (2 TO 100 SQUARE MILES) FROM NEW YORK TO ALABAMA.

MAPPING# RUNOFF# PRECIPITATION (METEOROLOGY)

73W-00-5053

73W 05053. ANALYSIS OF STOCHASTIC HYDROLOGIC SYSTEMS.
WATER RESOURCES RESEARCH. DECEMBER 1970. P1569-1582.
CHOW, VT# KARELIOTIS, SJ
ILLINOIS UNIV., URBANA

THE OBJECTIVE OF THIS STUDY WAS TO FORMULATE THE MATHEMATICAL MODEL OF A STOCHASTIC HYDROLOGIC SYSTEM AND THE MATHEMATICAL MODELS OF THE HYDROLOGIC PROCESSES IN THE SYSTEM, USING THE WATERSHED AS AN EXAMPLE OF THE HYDROLOGIC SYSTEM.

HYDROLOGY# STOCHASTIC PROCESSES# WATERSHEDS

73W-00-5054

73W 05054. A GENERAL NUMERICAL SOLUTION OF THE TWO DIMENSIONAL DIFFUSION CONVECTION EQUATION BY THE FINITE ELEMENT METHOD.
WATER RESOURCES RESEARCH. DECEMBER 1970. P1611-1617.
GUYMON, GL# SCOTT, VH# HERRMAN, LR
CALIFORNIA UNIV., DAVIS

THE TWO DIMENSIONAL DIFFUSION CONVECTION EQUATION, TOGETHER WITH THE APPROPRIATE AUXILIARY CONDITIONS, IS USED TO DESCRIBE APPROXIMATELY THE MOTION OF DISSOLVED CONSTITUENTS IN POROUS MEDIA FLOW, DISPERSION OF POLLUTANTS IN STREAMS, ENERGY TRANSFER IN RESERVOIRS, AND OTHER NATURAL TRANSPORT PROCESSES.

TWO DIMENSIONAL FLOW# LINEAR DIFFERENTIAL EQUATIONS

73W-00-5055

73W 05055. FLOOD SERIES COMPARED TO RAINFALL EXTREMES.
WATER RESOURCES RESEARCH. DECEMBER 1970. P1655-1667.
REICH, BM
PENNSYLVANIA STATE UNIV., UNIV., PARK

ANNUAL SERIES OF MAXIMUM INSTANTANEOUS FLOOD PEAKS FROM 26 PENNSYLVANIAN WATERSHEDS SMALLER THAN 200 SQUARE MILES WERE ANALYZED BY THE GUMBEL, LOG GUMBEL, AND LOG PEARSON 3 METHODS.

FLOODS# WATERSHEDS# RAINFALL

73W-00-5056

73W 05056. DEFINITION AND USES OF THE LINEAR REGRESSION MODEL.
WATER RESOURCES RESEARCH. DECEMBER 1970. P1668-1673.
DISKIN, MH
AGRICULTURE DEPT., TUCSON, ARIZ.

A SIMPLE THREE ELEMENT MODEL IS PROPOSED AS AN INTERPRETATION OF THE REGRESSION EQUATION FOR THE RELATIONSHIP BETWEEN ANNUAL RAINFALL AND ANNUAL RUNOFF FROM WATERSHEDS.

LINEAR REGRESSION# RAINFALL# WATERSHEDS

73W-00-5057

73W 05057. A COMPARATIVE STUDY OF CRITICAL DROUGHT SIMULATION.
WATER RESOURCES RESEARCH. FEBRUARY 1971. P52-62.
ASKEW, AJ# YEH, WW# HALL, WA
CALIFORNIA UNIV., LOS ANGELES

A SET OF MONTHLY STREAMFLOW RECORDS IS GENERATED AND ANALYZED TO GIVE A SET OF SYNTHETIC CRITICAL PERIODS.

DROUGHTS# STREAM FLOW# SIMULATION

73W-00-5058

73W 05058. SOIL MOISTURE DETECTION WITH IMAGING RADARS.
WATER RESOURCES RESEARCH. FEBRUARY 1971. P100-110.
MACDONALD, HC# WAITE, WP
KANSAS UNIV., LAWRENCE

THE DATA PRESENTED IN THIS STUDY SUGGEST THAT PRESENTLY AVAILABLE DUAL POLARIZED, K BAND, SIDE LOOKING IMAGING RADARS PROVIDE A CAPABILITY FOR REVEALING A QUALITATIVE ESTIMATE OF SOIL MOISTURE CONTENT.

SOIL WATER# SIDE LOOKING RADAR

73W-00-5059

73W 05059. DISCRETE DIFFERENTIAL DYNAMIC PROGRAMMING APPROACH TO WATER RESOURCES SYSTEMS OPTIMIZATION.
WATER RESOURCES RESEARCH. APRIL 1971. P273-282.
CHOW, MH# KOKOTOVIO, PV# MEREDITH, DD
ILLINOIS UNIV., URBANA

THE OPTIMIZATION OF OPERATING POLICIES OF MULTIPLE UNIT AND MULTIPLE PURPOSE WATER RESOURCES SYSTEMS BY TRADITIONAL DYNAMIC PROGRAMING WITH THE USE OF HIGH SPEED DIGITAL COMPUTERS ENCOUNTERS TWO MAJOR DIFFICULTIES: MEMORY REQUIREMENTS AND COMPUTER TIME REQUIREMENTS. THIS PAPER PRESENTS AN ITERATIVE METHOD THAT CAN EASE THE ABOVE DIFFICULTIES CONSIDERABLY.

DIFFERENTIAL EQUATIONS# DIGITAL COMPUTERS

73W-00-5060

73W 05060. OPERATIONAL HYDROLOGY FOR UNGAGED STREAMS BY THE GRID SQUARE TECHNIQUE.
WATER RESOURCES RESEARCH. APRIL 1971. P283-291.
PENTLAND, RL# CUTHBERT, DR
ENERGY, MINES, AND RESOURCES DEPT., OTTAWA, CANADA

THE GRID SQUARE TECHNIQUE AND ITS EXTENSION TO OPERATIONAL HYDROLOGY ARE DISCUSSED, ALONG WITH AN EXAMPLE FROM THE NEW BRUNSWICK REGION OF CANADA.

HYDROLOGY# STREAM FLOW# WATER RESOURCES

73W-00-5061

73W 05061. USE OF LINEAR PROGRAMMING FOR ESTIMATING GEOHYDROLOGIC PARAMETERS OF GROUND WATER BASINS.
WATER RESOURCES RESEARCH. APRIL 1971. P367-374.
KLEINECKE, D
GENERAL ELECTRIC CO., SANTA BARBARA, CALIF.

IN THIS REPORT TWO STUDIES ARE DISCUSSED THAT ATTEMPTED TO ESTIMATE GEOHYDROLOGIC PARAMETERS FROM ACTUAL BASIN RECORDS. DATA GATHERED BY THE CALIFORNIA STATE DEPARTMENT OF WATER RESOURCES (DWR) FOR THEIR SUCCESSFUL CHINO RIVERSIDE BASIN MODEL WERE USED.
THE FIRST APPROACH, PRESENTED BRIEFLY, WAS BASED ON A LEAST SQUARES FITTING PROCEDURE AND PROVED TO BE COMPLETELY UNSUCCESSFUL. THE SECOND APPROACH WAS BASED ON LINEAR PROGRAMING. ALTHOUGH IT HAS NOT PROVED ITS USE, AND THERE ARE SOME SUBSTANTIAL PROBLEMS, THE LINEAR PROGRAMING APPROACH OFFERS SOME PROMISE. THIS PAPER IS PRINCIPALLY A PROGRESS REPORT ON THE LINEAR PROGRAMING APPROACH.

GROUND WATER# LINEAR PROGRAMMING# HYDROGEOLOGY

73W-00-5068

RC-3069. TWO ALGORITHMS FOR MULTIPLE VIEW BINARY PATTERN RECONSTRUCTION. SEPTEMBER 1970.
CHANG, SK# SHELTON, GL
IBM YORKTOWN HEIGHTS, RESEARCH
RC-3069

13P. IN THIS PAPER THE PROBLEM OF RECONSTRUCTING BINARY PATTERNS FROM THEIR SHADOWS OR PROJECTIONS IS TREATED. TWO ALGORITHMS ARE FORMULATED. FOR THE TWO VIEW CASE, BOTH ALGORITHMS GIVE A PERFECT RECONSTRUCTION IF AND ONLY IF THE PATTERN IS TWO VIEW UNAMBIGUOUS. IT IS ALSO SHOWN THAT N VIEWS ARE SUFFICIENT, BUT NOT NECESSARY, TO RECONSTRUCT ANY N X N BINARY PATTERN. EXPERIMENTAL RESULTS FOR THE FOUR VIEW RECONSTRUCTION OF 25 X 25 BINARY PATTERNS INDICATE THAT ONE OF THE ALGORITHMS HAS GOOD CONVERGENCY BEHAVIOR.

DIGITAL SYSTEMS# ALGORITHMS

73W-00-5071

RC-3140. A SIMULATOR FOR NORTHEASTERN FOREST GROWTH; A CONTRIBUTION OF THE HUBBARD BROOK ECOSYSTEM STUDY AND IBM RESEARCH. NOVEMBER 1970.
BOTKIN, DB# JANAK, JF# WALLIS, JR
IBM YORKTOWN HEIGHTS, RESEARCH
RC-3140

21P. A NORTHEASTERN FOREST GROWTH SIMULATOR, JABOWA, HAS BEEN WRITTEN IN FORTRAN IV FOR USE UNDER TSS ON AN IBM 360-67. THE PROGRAM SIMULATES STAND GROWTH BY ANNUAL INCREMENTS FOR THE 13 TREE SPECIES OF THE NORTHERN HARDWOOD FOREST TYPE FOUND ON THE USFS HUBBARD BROOK EXPERIMENTAL WATERSHED AT WEST THORNTON, N.H. THREE TYPICAL SIMULATION EXPERIMENTS THAT MAY BE PERFORMED QUITE EASILY BY JABOWA ARE SHOWN, AND THE SOURCE PROGRAM IS LISTED SO THAT THE USER MAY QUICKLY DESIGN OTHERS WHILE AT A REMOTE COMPUTER TERMINAL (SUCH AS AN IBM 2741).

COMPUTERIZED SIMULATION# FORESTRY# IBM SYSTEM/ 360

73W-00-5072

RC-3203. BOUNDARY DETECTION OF RADIOGRAPHIC IMAGES BY A THRESHOLD METHOD. DECEMBER 1970.
CHOW, CK# KANEKO, T
IBM YORKTOWN HEIGHTS, RESEARCH
RC-3203

30P. A THRESHOLD METHOD BASED ON STATISTICAL PRINCIPLES AND HEURISTICS IS DEVELOPED TO DETECT BOUNDARIES IN RADIOGRAPHIC IMAGES. EACH LOCAL REGION OF THE IMAGE CONTAINING A PORTION OF BOUNDARY IS CHARACTERIZED BY A MIXTURE OF TWO (NORMAL) INTENSITY DISTRIBUTIONS. THRESHOLDS ARE SET DYNAMICALLY ACCORDING TO LOCAL, RATHER THAN GLOBAL, CHARACTERISTICS ESTIMATED FROM THE OBSERVED INTENSITY HISTOGRAMS. A PROGRAM TO IMPLEMENT THE METHOD HAS BEEN WRITTEN. EXPERIMENTAL RESULTS ON CARDIOANGIOGRAMS ARE PRESENTED TO SUCCESSFULLY DEMONSTRATE THE FEASIBILITY OF THE METHOD FOR LOW QUALITY IMAGES. THE METHOD IS INSENSITIVE TO SHADING OR GRADUALLY VARYING INTERFERENCE.

PATTERN RECOGNITION# RADIOGRAPHY# BOUNDARIES

73W-00-5080

N70-15687. A MODEL ATMOSPHERE FOR EARTH RESOURCES APPLICATIONS. NOVEMBER 1969.
PITTS, DE# KYLE, KD
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N70-15687# NASA-TMX-58033

49P. A COMPUTER SUBPROGRAM SET IS DESCRIBED WHICH PERMITS THE USE OF RADIOSONDE DATA TO PROVIDE MODEL ATMOSPHERE DATA FOR EARTH RESOURCES APPLICATIONS. ALL EARTH ESOURCES REMOTE-SENSING TECHNIQUES ARE AFFECTED BY THE ATMOSPHERE LYING BETWEEN THE TARGET AND THE SENSOR. THE COMPUTER PROGRAM PRESENTED IN THIS REPORT OFFERS A METHOD OF NUMERICAL USE OF RADIOSONDE DATA SO THAT ATMOSPHERIC EFFECTS MAY BE ASSESSED AND POSSIBLY REMOVED FROM THE SIGNAL.

REMOTE SENSING# RADIOSONDES# COMPUTER PROGRAMS
ATMOSPHERES

73W-00-5081

N70-16407. FURTHER INFRARED SYSTEMS STUDIES FOR THE EARTH RESOURCES PROGRAM. FINAL REPORT. DECEMBER 1969.
BRAITHWAITE, J# LARSEN, L# WORK, E.
MICHIGAN UNIV., ANN ARBOR
N70-16407# NASA-CR-102111# WRL-2122-14-F

77P. THIS REPORT DISCUSSES THE DEVELOPMENT OF DESIGN CONCEPTS AND SPECIFICATIONS FOR MULTISPECTRAL SCANNERS FOR USE FROM ORBIT AS PART OF THE EARTH RESOURCES PROGRAM. THE PERFORMANCE OF SUCH SCANNERS MAY BE LIMITED BY COMPONENT PERFORMANCE, BY WEIGHT AND POWER ALLOCATIONS, AND BY THE DATA RATES AND BULKS WHICH CAN BE RETURNED TO THE GROUND. SOME OF THE MORE CRITICAL OF THESE FACTORS HAVE BEEN EXAMINED IN DETAIL, AND METHODS OF DEALING WITH THEM HAVE BEEN INVESTIGATED. IT IS SHOWN, FOR EXAMPLE, THAT A 7 CHANNEL SCANNER WITH A 200 FT GROUND RESOLUTION IS FEASIBLE, BUT THAT THE SWATH WIDTH WOULD BE LIMITED TO LESS THAN 20 MILES UNLESS TELEMETRY BANDWIDTHS LARGER THAN THOSE IN CURRENT USE ARE MADE AVAILABLE.

INFRARED SCANNERS# INFRARED DETECTORS# TELEMETRY

73W-00-5082

N70-17026 THRU N70-17034. PROCEEDINGS OF THE WINTER STUDY ON USES OF MANNED SPACE FLIGHT, 1975-1985. VOLUME 2: APPENDIXES. 1969.
NASA, WASHINGTON, D.C.
N70-17026 THRU N70-17034# NASA-SP-196-VOL-2

177P. CONTENTS: 1. MANNED SPACE-FLIGHT CAPABILITIES, APPENDIX A (SEE N70-17027), 2. LOW COST SPACE TRANSPORTATION. APPENDIX B (SEE N70-17028), 3. THE LUNAR PROGRAM, APPENDIX C (SEE N70-17029), 4. ASTRONOMY, APPENDIX D (SEE N70-17030), 5. SPACE PHYSICS, APPENDIX E (SEE N70-17031), 6. EARTH SCIENCES AND APPLICATIONS, APPENDIX F (SEE N70-17032), 7. LIFE SCIENCES, APPENDIX G (SEE N70-17033), 8. MATERIALS SCIENCE AND PROCESSING IN SPACE, APPENDIX H (SEE N70-17034).

MANNED SPACE FLIGHT# ASTRONOMY# EARTH SCIENCES

73W-00-5083

N70-17429. EARTH RESOURCES DATA PROCESSING CENTER STUDY. VOLUME 2: STUDY FINDINGS. SEPTEMBER 1969.
FAIRCHILD CAMERA AND INSTRUMENT CORP., SYOSSET, N.Y.
N70-17429# NASA-CR-107887# ED-AA-113

308P. A REVIEW IS PRESENTED OF THE BASIC OBJECTIVES AND REQUIREMENTS OF THE MAJOR GOVERNMENT SUPPORT AGENCIES AND EXPERIMENTER GROUPS ASSOCIATED WITH THE EARTH RESOURCES PROGRAM, AS WELL AS THE SENSOR AND AUXILIARY EQUIPMENTS ASSOCIATED WITH THE MANNED SPACECRAFT CENTER AIRCRAFT SURVEY PROGRAM. DATA FLOW MODELS ARE DEVELOPED WHICH DEPICT THE PROCESSING OF TYPICAL DATA FROM EACH SENSOR CLASS THROUGH THE ASSOCIATED MSC GROUND DATA PROCESSING FACILITY. FUTURE TRENDS IN THE EARTH RESOURCES PROGRAM ARE DELINEATED, WITH EMPHASIS ON THE HOUSTON AIRCRAFT PROGRAM, ITS EVENTUAL COORDINATION WITH SPACECRAFT COLLECTION ACTIVITIES, AND ITS ATTENDANT GROUND DATA PROCESSING REQUIREMENTS. PRIORITY TECHNIQUES, SYSTEM AND FACILITIES GROWTH REQUIREMENTS ARE IDENTIFIED. DEVELOPMENT PLANS ARE PRESENTED TO PERMIT THE TIMELY RESEARCH, DEVELOPMENT, CONSTRUCTION AND TEST OF REQUIRED PROCESSING EQUIPMENT AND FACILITIES. RECOMMENDATIONS AND CONCLUSIONS CONCERNING FUTURE EFFORT AIMED AT FURTHERING THE GROWTH OF THE EARTH RESOURCES DATA PROCESSING FACILITIES AT THE MANNED SPACECRAFT CENTER ARE DEVELOPED.

DATA PROCESSING# REMOTE SENSING# RESOURCES

73W-00-5084

N70-17721. EARTH RESOURCES DATA PROCESSING CENTER STUDY. VOLUME 1: PROGRAM SUMMARY. FINAL REPORT. SEPTEMBER 1969.
FAIRCHILD CAMERA AND INSTRUMENT CORP., SYOSETT, N.Y.
N70-17721# NASA-CR-107884# NASW-1811# ED-AA-113

47P. THE RESULTS OF A COMPREHENSIVE STUDY AIMED AT ASSISTING NASA HEADQUARTERS IN ITS TASK OF PLANNING R AND D PROGRAMS AND DEVELOPING AN OPERATIONAL CAPABILITY TO ACQUIRE, PROCESS AND DISSEMINATE REMOTELY SENSED EARTH RESOURCES DATA TO APPROPRIATE EXPERIMENTERS AND USERS ARE DESCRIBED. A REVIEW IS PRESENTED OF THE BASIC OBJECTIVES AND REQUIREMENTS OF THE MAJOR GOVERNMENT SUPPORT AGENCIES AND EXPERIMENTER GROUPS ASSOCIATED WITH THE EARTH RESOURCES PROGRAM. FUTURE TRENDS IN THE EARTH RESOURCES PROGRAM ARE DELINEATED, WITH EMPHASIS ON THE HOUSTON AIRCRAFT PROGRAM, ITS EVENTUAL COORDINATION WITH SPACECRAFT COLLECTION ACTIVITIES, AND ITS ATTENDANT GROUND DATA PROCESSING REQUIREMENTS. RECOMMENDATIONS AND CONCLUSIONS CONCERNING FUTURE EFFORT AIMED AT FURTHERING THE GROWTH OF THE EARTH RESOURCES DATA PROCESSING FACILITIES AT THE MANNED SPACECRAFT CENTER ARE DEVELOPED.

DATA PROCESSING# REMOTE SENSING

73W-00-5085

N70-21089. MANAGEMENT, PROCESSING AND DISSEMINATION OF SENSORY DATA FOR THE EARTH RESOURCE TECHNOLOGY SATELLITE. DECEMBER 1969.
MERRITT, ES# AHLIN, WC# GOLDSHLAK, L
ALLIED RESEARCH ASSOCIATES, INC., CONCORD, MASS.
N70-21089# NASA-CR-109081# REPT-9G45-43
TR-11# NAS5-10343

135P. THE ELEMENTS OF A DATA CENTER FOR THE MANAGEMENT, PROCESSING AND DISSEMINATION OF PHOTOGRAPHIC PRODUCTS GENERATED BY THE EARTH RESOURCE TECHNOLOGY SATELLITE (ERTS) IS SPECIFIED. IN ADDITION TO THE SPECIFICATION OF FUNCTIONAL ELEMENTS, THIS STUDY EXAMINES AND PROVIDES SPECIFICATION OF: DATA RATES AND DATA FLOW TIME LINES; FACILITY, EQUIPMENT AND MATERIAL REQUIREMENTS FOR A ONE YEAR OPERATION OVER THE CONTINENTAL UNITED STATES; AND SOME PRELIMINARY ANALYSES OF PHOTOGRAPHIC PROCESSING AND MATERIALS THAT CAN INFLUENCE PICTURE ELEMENT ACCURACIES. A PLAN IS PRESENTED FOR THE FURTHER IMPLEMENTATION STEPS NECESSARY TO PROVIDE AN OPERATING DATA CENTER IN TIME FOR AN ERTS LAUNCH IN EARLY 1972.

DATA PROCESSING# PHOTOGRAPHY# REMOTE SENSING

73W-00-5086

N70-21145. SPATIAL SURVEILLANCE OF NATURAL RESOURCES. JANUARY 1969.
RAITT, DI
ROYAL AIRCRAFT ESTAB., FARNBOROUGH, ENGLAND
N70-21145# RAE-LIB-BIB-308

23P. THIS SELECTIVE BIBLIOGRAPHY COVERS THE PERIOD 1946 TO DATE. IN GENERAL THE COVERAGE IS OF THE FOLLOWING FIELDS: MINERAL DEPOSITS, AGRICULTURE (VEGETATION, CROPS, SOILS), FORESTRY (DISEASE, FIRE), WILDLIFE, LIVESTOCK AND WATER RESOURCES. A SELECT LIST OF REFERENCES ON APPLICATIONS SATELLITES IS ALSO INCLUDED.

REMOTE SENSING# ARTIFICIAL SATELLITES

73W-00-5087

N70-22676. APOLLO 9 MULTISPECTRAL PHOTOGRAPHIC INFORMATION. APRIL 1970.
KALTENBACK, JL
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N70-22676# NASA-TMX-1957# S-226

33P. THE NASA EXPERIMENT S065 MULTISPECTRAL PHOTOGRAPHY FLOWN ON THE APOLLO 9 MISSION PROVIDED ORBITAL PHOTOGRAPHY OF THE EARTH. THE PHOTOGRAPHY WAS TAKEN BY FOUR CAMERAS, EACH OF WHICH CONTAINED A DIFFERENT FILM FILTER COMBINATION. SPECIAL COLOR VIEWING AND REPRODUCTION SYSTEMS ARE BEING USED TO DETERMINE THE USE AND VALUE OF MULTISPECTRAL PHOTOGRAPHY TO THE EARTH RESOURCES DISCIPLINES AND TO APPLY THESE FINDINGS TO THE DESIGN OF FUTURE IMAGING SYSTEMS.

REMOTE SENSING# PHOTOGRAPHY# FILMS# FILTERS

73W-00-5088

N70-23540. USEFUL APPLICATIONS OF EARTH ORIENTED SATELLITES: SYSTEMS FOR REMOTE SENSING INFORMATION AND DISTRIBUTION. 1969.
NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D.C.
N70-23540# NASA-CR-109352

99P. THE PROBLEMS AND POTENTIAL FOR THE USE OF DATA GATHERED BY REMOTE SENSING OR DISTRIBUTED COLLECTION DEVICES WITH COLLECTION FROM SATELLITE OR AIRCRAFT ARE CONSIDERED. THE CONSIDERATIONS INCLUDED THE COLLECTION, PROCESSING, STORAGE, AND DISTRIBUTION OF THESE DATA IN BOTH PROCESSED AND RAW FORM. IN GENERAL, THE PROBLEMS CONSIDERED FOCUSED PRIMARILY ON THOSE DATA PROCESSING ASPECTS OF THE TOTAL SYSTEM THAT LIE BETWEEN THE RECEIVING GROUND STATION AND THE USER. INEVITABLY, HOWEVER, BROADER JUDGMENTS WERE REACHED ON OVERALL SYSTEMS ASPECTS, PARTLY BECAUSE OF THE NEED FOR MISSION PLANNING AND CONTROL IN THE DATA PROCESSING SYSTEM, PARTLY BECAUSE OF THE INEVITABLE NEED TO DESIGNATE OPERATIONAL PRIORITIES FOR THE COLLECTION AND DISSEMINATION OF DATA.

REMOTE SENSING# ARTIFICIAL SATELLITES

73W-00-5089

N70-31579. SPACE STATION: KEY TO THE FUTURE. 1970.
NASA, WASHINGTON, D.C.
N70-31579# NASA-EP-75

42P. THE SPACE STATION AND SOME OF ITS FUTURE BENEFITS ARE DESCRIBED IN NONTECHNICAL TERMS TAKEN FROM INFORMATION THAT HAS BEEN PRESENTED AT TECHNICAL CONFERENCES. POSSIBLE BENEFITS ARE: (1) DETECTION OF LARGE SCALE DYNAMIC EARTH PHENONMENA SUCH AS CHANGES IN SNOW PACK, AIR AND WATER POLLUTION, AND OCCURRENCES IN REMOTE AREAS: (2) MAINTENANCE OF METEOROLOGICAL SATELLITES: (3) PROSPECTING FOR MINERAL RESOURCES: (4) CROP CONDITION IDENTIFICATION: AND (5) LOCATING AREAS OF SUBTERRANEAN WATER SOURCES. SPACE STATION CONFIGURATIONS AND CREW REQUIREMENTS ARE DISCUSSED.

SPACE STATIONS# METEOROLOGICAL SATELLITES
EXPLORATION# POLLUTION# WATER RESOURCES

73W-00-5090

N70-35895. REMOTE SENSING: A SURVEY REPORT. AUGUST 1967.
CRAIB, KB
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N70-35895# NASA-TMX-65067# MSC-CA-R-67-2

132P. A SURVEY OF REMOTE SENSING TECHNIQUES AND MEASUREMENT SYSTEMS IS CONSIDERED BY AREA OF APPLICATION AS EXTRATERRESTRIAL, ATMOSPHERIC, AND GEOPHYSICAL. BASIC ENERGY EQUATIONS, INTERACTIONS, AND ENVIRONMENTAL RESTRICTIONS ARE REVIEWED. SENSOR SYSTEMS USED IN EACH AREA ARE PRESENTED, DATA SAMPLES ARE SHOWN, AND INFORMATION CONTENT IS DISCUSSED. THE ADVANTAGES PROVIDED BY MULTISPECTRAL SCANNING FROM HIGH ALTITUDE OBSERVATION PLATFORMS ARE SHOWN.

REMOTE SENSING# ARTIFICIAL SATELLITES

73W-00-5092

AD699620. SATELLITE IMAGERY OF THE EARTH. JULY 1969.
MERIFIELD, PM# CRONIN, J# FOSHEE, SJ# NEAL, JT
AIR FORCE CAMBRIDGE RESEARCH LABS., BEDFORD, MASS.
AD699620# AFCRL-70-0037

14P. REPRINTED FROM "PHOTOGRAMMETRIC ENGINEERING", V35, N7, P654-668, JULY 1969.
PHOTOGRAPHY OF THE EARTH FROM SPACECRAFT HAS APPLICATION TO BOTH ATMOSPHERIC AND EARTH SCIENCES. GEMINI AND APOLLO PHOTOGRAPHS HAVE FURNISHED INFORMATION ON SEA SURFACE ROUGHNESS, AREAS OF POTENTIAL UPWELLING AND OCEANIC CURRENT SYSTEMS. REGIONAL GEOLOGIC STRUCTURES AND GEOMORPHOLOGIC FEATURES ARE ALSO RECORDED IN ORBITAL PHOTOGRAPHS. INFRARED SATELLITE IMAGERY PROVIDES METEOROLOGICAL AND HYDROLOGICAL DATA AND IS POTENTIALLY USEFUL FOR LOCATING FRESH WATER SPRINGS ALONG COASTAL AREAS, SOURCES OF GEOTHERMAL POWER AND VOLCANIC ACTIVITY. GROUND AND AIRBORNE SURVEYS ARE BEING UNDERTAKEN TO CREATE A BASIS FOR THE INTERPRETATION OF DATA OBTAINED FROM FUTURE SATELLITE SYSTEMS.

EARTH /PLANET/# METEOROLOGICAL SATELLITES# HYDROLOGY
INFRARED SCANNERS# AERIAL PHOTOGRAPHS

73W-00-5093

N71-28126. EARTH RESOURCES SATELLITES. OCTOBER 1969.
ENTRES, SL
ROYAL AIRCRAFT ESTAB., FARNBOROUGH, ENGLAND
N71-28126# RAE-TR-69219

88P. OPERATIONAL AND TECHNICAL ASPECTS OF EARTH RESOURCES SATELLITE PROJECTS ARE DISCUSSED. TWO BASIC SURVEYING METHODS ARE CONSIDERED: BY REMOTE SENSING SATELLITES AND BY MEASUREMENT COLLECTING SATELLITES. ATTENTION IS CONCENTRATED ON PROBLEMS OF ORBITAL SENSING OF ELECTROMAGNETIC EARTH RADIANCE IN THE VISUAL, INFRARED AND MICROWAVE REGIONS. THE PRINCIPLES OF POLYCHROMATIC MEASUREMENT OF EARTH SURFACE RADIATION SIGNATURES AND THEIR ANALYSIS AS WELL AS SOME MATTERS CONNECTED WITH THE DATA HANDLING OF THE SENSED INFORMATION ARE DISCUSSED. RECOMMENDATIONS ARE MADE FOR SOME USEFUL FIELDS OF STUDY AND FOR COMPLEMENTARY EXPERIMENTAL WORK. A LIST OF ORGANIZATIONS ENGAGED IN RELEVANT BRANCHES OF SCIENCE AND TECHNOLOGY TOGETHER WITH CLASSIFIED BIBLIOGRAPHIC REFERENCES ARE APPENDED.

ARTIFICIAL SATELLITES# REMOTE SENSING# RESOURCES
TERRESTRIAL RADIATION

73W-00-5094

N70-40086. REMOTE SENSING. MAY 1970.
SVENNSON, H.
AIR FORCE CAMBRIDGE RESEARCH LABS., BEDFORD, MASS.
N70-40086# AD707824# AFCRL-70-0277

10P. THE PARTS OF THE ELECTROMAGNETIC SPECTRUM ARE DISCUSSED, WITH THE TYPE (S) OF SENSOR (S) REQUIRED TO RECORD ENERGY IN EACH PART. A REVIEW IS GIVEN OF THE CLASSES OF AIRBORNE (AND SATELLITE) REMOTE SENSOR DATA WHICH ARE AVAILABLE TO GEOSCIENTISTS. DIFFERENT TYPES OF REMOTE SENSOR DATA ARE DESCRIBED AND EXAMPLES PROVIDED, INCLUDING PANCHROMATIC, INFRARED, COLOR, AND COLOR INFRARED AERIAL PHOTOGRAPHY (KULLABERG, SWEDEN): MULTISPECTRAL AERIAL PHOTOGRAPHY (WITH IMPORTANCE OF OPTIMUM FILM/FILTER COMBINATION FOR SPECIFIC PHENOMENA): AIRBORNE THERMAL INFRARED IMAGERY (KULLABERG, SWEDEN AND SURTSEY, ICELAND): SIDE LOOKING AIRBORNE RADAR (TUSKAHOMA SYNCLINE, OKLAHOMA): AND RADIO SOUNDING OF GLACIAL ICE (ANTARCTICA). THE PROJECTED FUTURE INCREASE IN AMOUNT OF REMOTE SENSOR DATA WILL REQUIRE COMPUTER PROCESSING TECHNIQUES, ALTHOUGH MAN WILL SERVE THE MOST IMPORTANT ROLE IN THE ANALYSIS AND USE OF REMOTE SENSOR INFORMATION OF THE EARTHS SURFACE.

REMOTE SENSING# ELECTROMAGNETIC SPECTRA
ARTIFICIAL SATELLITES# INFRARED DETECTION
AERIAL PHOTOGRAPHY# SIDE LOOKING RADAR

73W-00-5095

N70-25981. ECOLOGICAL SURVEYS FROM SPACE. 1970.
NASA, WASHINGTON, D.C.
N70-26981# NASA-SP-230

80P. THE USE OF SPACECRAFT FOR EARTH RESOURCES SURVEYS IS DISCUSSED FOR SEVEN DIFFERENT DISCIPLINES, WHICH INCLUDE GEOGRAPHY, AGRICULTURE, FORESTRY, GEOLOGY, HYDROLOGY, OCEANOGRAPHY, AND CARTOGRAPHY. PHOTOGRAPHS TAKEN WITH DIFFERENT FILTERS AND TYPES OF FILM FROM THE GEMINI AND APOLLO FLIGHTS ILLUSTRATE THE MAN MADE CHANGES OF THE EARTH'S SURFACE AS WELL AS NATURAL RESOURCES.

REMOTE SENSING# ARTIFICIAL SATELLITES# ECOLOGY

73W-00-5096

N69-40391. MODIFICATION OF 16.5 GHZ SIDE LOOKING RADAR SYSTEM FOR NASA C-130 AIRCRAFT. FINAL REPORT. SEPTEMBER 1969.
MCCAIN, RE
PHILCO FORD CORP., NEWPORT BEACH, CALIF.
N69-40391# NASA-CR-101746# NAS9-9116# PUBL-U-4710

20P. TECHNICAL DETAILS ARE GIVEN ON THE MODIFICATIONS MADE TO THE SIDE LOOKING RADAR DESIGNED FOR INSTALLATION IN A C-130 AIRCRAFT IN SUPPORT OF THE NASA EARTH RESOURCES PROGRAM. THE DELIVERED RADAR SYSTEM CONSISTS OF A MODIFIED AN/DPD-2 RADAR ELECTRONIC ASSEMBLY, MULTIPLE POLARIZED ANTENNA, CONTROL PANEL, AND ANTENNA PRESSURIZATION SYSTEM. SPECIAL TEST EQUIPMENT IN THE FORM OF A SYSTEM PREFLIGHT CALIBRATOR AND RECORDER CALIBRATOR WAS FABRICATED AND DELIVERED TO SUPPORT THE ALIGNMENT, CHECKOUT, AND CALIBRATION OF THE RADAR SYSTEM. IN ADDITION, COMPONENT AND ASSEMBLY SPARES WERE PROCURED, FABRICATED, AND DELIVERED TO SUPPORT THE RADAR SYSTEM DURING THE FLIGHT TEST PROGRAM.

SIDE LOOKING RADAR# INSTALLING# RELIABILITY

73W-00-5097

RC-3115. THREE DIMENSIONAL TRANSIENT, SATURATED-UNSATURATED FLOW IN A GROUND WATER BASIN. OCTOBER 1970.
FREEZE, RA
IBM YORKTOWN HEIGHTS, RESEARCH
RC-3115

43P. THE REQUIREMENTS OF WATER RESOURCE PLANNING HAVE MADE SIMULATION OF THE HYDROLOGIC RESPONSE OF GROUND WATER BASINS A TECHNIQUE OF INCREASING IMPORTANCE. IN THIS REPORT A NUMERICAL MATHEMATICAL MODEL IS PRESENTED THAT ATTEMPTS TO BRING THE STATE OF THE SCIENCE ONE STEP CLOSER TO HYDROGEOLOGICAL REALITY.

GROUND WATER# HYDROGEOLOGY# WATER RESOURCES
MATHEMATICAL MODELS

73W-00-5098

AD692627. USE OF THE PROPERTIES OF THE SOIL COVER IN THE INTERPRETATION OF GROUND WATER ON AERIAL PHOTOGRAPHS. 1962.
KUZNETSOV, VV
ARMY FOREIGN SCIENCE AND TECH. CENTER, WASHINGTON, D.C.
AD692627# N70-11024# FSTC-HT-23-393-68

9P. A STUDY WAS MADE OF THE RELATIONSHIPS BETWEEN THE SOIL COVER AND GROUND WATER USING AERIAL PHOTOGRAPHS TAKEN IN DIFFERENT LANDSCAPE AREAS IN THE NORTHERN CASPIAN LOWLAND AND TURKEMENIA. THE WORK WAS DONE IN KEY AREAS TOGETHER WITH GEOBOTANICAL, GEOMORPHOLOGICAL AND HYDROLOGICAL STUDIES. IT WAS FOUND THAT A STUDY OF THE SOIL COVER (THICKNESS OF GENETIC HORIZONS, COLOR, MOISTURE CONTENT, HUMUS CONTENT, CONTENT OF SALTS, ETC., AS WELL AS THE CHARACTERISTICS OF THE STRUCTURE AND MECHANICAL COMPOSITION OF THE -SOILS) GIVES INFORMATION ON THE CHARACTER AND DEPTH OF GROUND WATER. SOILS BENEATH WHICH FRESH GROUND WATER IS SITUATED CLOSE TO THE SURFACE APPEAR ON AERIAL PHOTOGRAPHS IN DARK TONES.

GROUND WATER# SOILS# AERIAL PHOTOGRAPHY

73W-00-5099

73W 05099. CONSIDERATIONS IN CHOOSING THE ORBIT FOR AN EARTH RESOURCES SURVEY SATELLITE. JULY 1969.
OTTERMAN, J# BACHOFER, BT
GENERAL ELECTRIC CO., VALLEY FORGE, PA.

10P. THE ORBIT PARAMETERS BEST SUITED FOR EARTH RESOURCES SURVEY SATELLITES HAVE BEEN AND WILL CONTINUE TO BE THE SUBJECT OF MANY STUDIES. THIS PAPER ADDRESSES ITSELF TO THE SELECTION OF ONE OF THE IMPORTANT ORBITAL ELEMENTS FOR THE EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS) MISSION - THE LOCAL TIME AT THE ASCENDING NODE.

ARTIFICIAL SATELLITES# REMOTE SENSING# ORBITS

73W-00-5100

N70-14447. FEASIBILITY STUDY OF MICROWAVE RADIOMETRIC REMOTE SENSING. VOLUME 2: COMPUTER PRINTOUTS. JANUARY 1969.
PORTER, RA# FLORANCE, ET
ELECTRONICS RESEARCH CENTER, CAMBRIDGE, MASS.
N70-14447# NASA-CR-86297# NAS12-629

249P. PRINTOUTS OF COMPUTED TARGET AND BACKGROUND BRIGHTNESS TEMPERATURES AND CONTRASTS ARE GIVEN, AS WELL AS PRINTOUTS OF COMPUTED SKY BRIGHTNESS TEMPERATURES AND ATMOSPHERIC TRANSMISSION FACTORS.

REMOTE SENSING# PRINTOUTS# SKY BRIGHTNESS

73W-00-5101

N70-14448. FEASIBILITY STUDY OF MICROWAVE RADIOMETRIC REMOTE SENSING. VOLUME 3: ADDITIONAL PLOTS AND PRINTOUTS. JANUARY 1969.
PORTER, RA# FLORANCE, ET
ELECTRONICS RESEARCH CENTER, CAMBRIDGE, MASS.
N70-14448# NASA-CR-86298# NAS12-629

177P. PRINTOUTS OF SAMPLE MEASURED APPARENT TEMPERATURES AND DERIVED BRIGHTNESS TEMPERATURES, AND THEORETICAL EMISSIVITY AND BRIGHTNESS TEMPERATURE FOR FRESH AND SEA WATER ARE GIVEN. PLOTTED THEORETICAL BRIGHTNESS TEMPERATURES OF SEA WATER IN THE RANGE OF 17 TO 220 GHZ, AND THEORETICAL BRIGHTNESS TEMPFRATURES OF FRESH WATER IN THE RANGE OF 1 TO 220 GHZ ARE ALSO GIVEN.

REMOTE SENSING# WATER# SEA WATER# FRESH WATER
PRINTOUTS

73W-00-5102

N70-17428. OPTIMIZATION OF MICROWAVE RADIOMETRIC SYSTEMS FOR EARTH RESOURCE SURVEYS. JUNE 1969.
EWEN, HI# BARRETT, AH
EWEN KNIGHT CORP., EAST NATICK, MASS.
N70-17428# NASA-CR-86316# NAS12-2047

177P. PASSIVE MICROWAVE SENSING PROJECTS INSTRUMENTATION, AND TECHNIQUES ARE DISCUSSED. STUDIES AND ANALYTICAL MODELS ARE REVIEWED IN THE AREAS OF OCEANOGRAPHY AND MARINE TECHNOLOGY, GEOLOGY AND HYDROLOGY, GEOGRAPHY AND CARTOGRAPHY, AND AGRICULTURE AND FORESTRY. PRESENT GROUND BASED AND AIRCRAFT MEASUREMENTS ARE DESCRIBED AND INSTRUMENT TECHNOLOGY REQUIREMENTS ARE ANALYZED. AIRBORNE PARAMETRIC DISPLAYS WITH ATTENDANT LABORIOUS DATA REDUCTION REQUIREMENTS AND INEFFECTIVE USE OF AIRCRAFT FLIGHT TIME REDUCE THIS FORM OF DATA DISPLAY TO MINIMAL USE. AIRCRAFT IMAGERY TECHNIQUES ARE CONSIDERED TO BE NOT OPTIMUM. IT IS SUGGESTED THAT AN EXPERIMENTAL INVESTIGATION OF THE POTENTIAL BENEFITS OF PASSIVE REMOTE SENSING BE MADE, UTILIZING MORE DIRECT PARTICIPATION BY USERS IN THE PLANNING AND EXECUTION PHASES. IT IS FELT THAT MICROWAVE ANTENNA SIZE REQUIREMENTS ARE INCOMPATIBLE WITH PRESENT DAY JET AND PISTON TYPE AIRCRAFT, BUT ARE COMPATIBLE WITH SATELLITES. AN ENGINEERING PLAN IS OUTLINE FOR THE DEVELOPMENT OF INSTRUMENT TECHNOLOGY, BASED ON THE BUILDING BLOCK APPROACH.

REMOTE SENSING# MICROWAVES# OCEANOGRAPHY
HYDROLOGY# GEOLOGY# FORESTRY# MAPPING

73W-00-5103

N70-27083. AN ANALYSIS OF AIRBORNE MICROWAVE RADIOMETRIC DATA. FEBRUARY 1970.
RADIOMETRIC TECH., INC., CAMBRIDGE, MASS.
N70-27083# NASA-CR-109846# NAS5-11685

130P. DATA FROM MEASUREMENTS TAKEN IN 1967, 1968, AND 1969 OVER OCEAN AND LAND AREAS BY A 19.35 GHZ PHASED ARRAY SCANNER ABOARD THE NASA CONVAIR 990 ARE ANALYZED. OF PARTICULAR INTEREST ARE DATA WHICH RELATE TO THE RADIATION EMITTED AND AFFECTED BY CLOUDS. OTHER DATA FROM SENSORS MEASURING ENERGY AT IR WAVELENGTHS, TEMPERATURE IN SITU, AND, FOR THE FLIGHTS IN 1969, ENERGY AT 9.3 GHZ, ARE UTILIZED TO RECONSTRUCT ATMOSPHERIC, SURFACE, AND CLOUD CHARACTERISTICS. THEORETICAL BRIGHTNESS TEMPERATURES DERIVED FROM CLOUD MODELS, CONSISTENT WITH THE PHYSICAL DATA AVAILABLE, ARE IN GENERAL AGREEMENT WITH THE BRIGHTNESS TEMPERATURES OBSERVED OVER OCEAN AREAS. ALTHOUGH A SOMEWHAT LIMITED EFFECT IS EVIDENCED BY CLOUDS OVER DRY BARE SOIL AND VEGETATION AREAS, A REASONABLY PRONOUNCED EFFECT APPEARS POSSIBLE OVER MOIST SOILS. ANALYSIS OF THOSE CASES IN WHICH COMPUTED BRIGHTNESS TEMPERATURES DO NOT MATCH THE OBSERVED BRIGHTNESS TEMPERATURES INDICATES EITHER: (1) THE EXISTENCE OF CLOUD DROPLETS LARGER THAN CAN BE TREATED SUCCESSFULLY BY THE SIMPLE RAYLEIGH THEORY UTILIZED: OR (2) THE INCOMPLETENESS OF THE CLOUD MODELS THEMSELVES.

AIRBORNE DETECTORS# MICROWAVES# RADIOMETRY
PHASED ARRAYS# CLOUDS /METEOROLOGY/

73W-00-5104

N70-32931. PHENOMENA AND PROPERTIES OF GEOLOGIC MATERIALS AFFECTING MICROWAVES: A REVIEW. APRIL 1970.
OBERSTE-LEHN, D
STANFORD UNIV., CALIF.
N70-32931# NASA-CR-108547# NAS9-7313# SU-TR-70-10

72P. A LITERATURE SEARCH MADE ON MICROWAVE REMOTE SENSING INCLUDED MATERIAL ON ELECTROMAGNETIC THEORY, PARAMETERS AFFECTING PASSIVE MICROWAVE SYSTEMS, AND PROPERTIES OF NATURAL OCCURRING MATERIALS. SOME RESULTS AND CONCLUSIONS REACHED WERE: (1) DATA ON ELECTRIC AND THERMAL PROPERTIES OF MATERIALS ARE LACKING IN QUALITY AND QUANTITY: (2) SYSTEMATIC ANALYSES ARE NEEDED OF PARAMETERS IN THE MICROWAVE PORTION OF THE SPECTRUM UNDER CONDITIONS THAT WOULD MAKE THE DATA USEFUL FOR REMOTE SENSING PURPOSES: (3) THE COMPLEX COMPOSITIONAL, STRUCTURAL, AND TEMPORALLY DEPENDENT MAKEUP OF THE NATURAL ENVIRONMENT SUGGESTS THAT EVEN A FUNDAMENTALLY SOUND KNOWLEDGE OF ELEMENTAL INTERACTIONS WITH ELECTROMAGNETIC RADIATION IS PROBABLY INSUFFICIENT TO COMPLETELY SOLVE REAL WORLD PROBLEMS: AND (4) THE EMPIRICAL APPROACH OF MAKING PARAMETRIC MEASUREMENTS UNDER CAREFULLY SELECTED FIELD CONDITIONS MAY PROVIDE BETTER INSIGHT INTO THE CAUSES OF THE INTEGRATED RESPONSES RECORDED BY PASSIVE MICROWAVE SYSTEMS.

REMOTE SENSING# MICROWAVES# ELECTROMAGNETIC THEORY

73W-00-5105

N70-38843. HYDROLOGIC INTERPRETATION OF NIMBUS VIDICON IMAGE: GREAT SALT LAKE, UTAH. NOVEMBER 1966.
HAHL, DC# HANDY, AH
GEOLOGICAL SURVEY, WASHINGTON, D.C.
N70-38843# NASA-CR-79887

6P. THE ANALYSIS WAS MADE TO DETERMINE IF FEATURES OF HYDROLOGIC SIGNIFICANCE WERE VISIBLE AND IDENTIFIABLE. THE FEATURES THAT ARE POINTED OUT ON AN ANNOTATED COPY OF THE IMAGE INDICATE SOME OF THE FACTORS THAT ARE REQUIRED TO PRODUCE AN IMAGE. VEGETATION AND GEOLOGY MAY BE RESPONSIBLE FOR THE DELINEATION OR LACK OF DELINEATION OF SOME FEATURES. DEPTH IS NOT CONSIDERED A FACTOR IN PRODUCING AN IMAGE. THE IMPLICATIONS OF USING THE ADVANCED VIDICON CAMERA SYSTEM IN THE FIELD OF HYDROLOGY ARE ASSESSED.

HYDROLOGY# VIDICONS# IMAGES# REMOTE SENSING

73W-00-5106

N70-40343. NUKLEONIKA, VOLUME 13, NO. 4-5, P361-590, 1968.
COMMERCE DEPT.
N70-40343# AEC-TR-6931/4-5# TT-68-50011/4-5

229P. PAPERS PRESENTED INCLUDE: DETERMINATION OF MAIN COMPONENTS IN ORES BY RADIOMETRIC METHODS, PULSED NEUTRON SOURCE AND BORE HOLE FAST NEUTRON GENERATOR DESIGN, RADIOMETRIC MEASUREMENT OF FILTER TUBE DEPTH IN BORE HOLES, ENERGY DISTRIBUTION OF SCATTERED GAMMA RAYS IN NATURAL GAMMA LOGGING, ELIMINATION OF CHEMICAL COMPOSITION EFFECTS OF ROCKS ON GAMMA-GAMMA DENSITY LOGGING, APPLICATIONS OF ISOTOPIC METHODS FOR DETERMINING PHYSICAL PROPERTIES OF SOILS IN GEOTECHNICAL CROSS SECTION STRUCTURE, AND THE USE OF TRITIUM IN HYGROGEOLOGICAL STUDIES. ALSO DISCUSSED ARE RADIOMETRIC METHODS FOR STUDYING WATER RESERVOIR BOTTOM TIGHTNESS AND AN INORGANIC SUBSTANCE IN HARD AND BROWN COALS, SINGLE WELL ISOTOPIC METHODS FOR DRAINING PURPOSES IN A MINE, NUCLEAR MEASUREMENT FOR SOIL MOISTURE AND DENSITY, WELL LOGGING FOR SOLID RAW MATERIAL DEPOSIT DETECTION, AND ANALYSIS OF COPPER AND SILVER IN COPPER ORES BY THE PHOTON ACTIVATION METHOD. A RADIOGRAPHIC PROBE WAS USED TO DETERMINE THE DIRECTION OF GROUND WATER FILTRATION IN DRILL HOLES AND THE DIRECTION AND FLOW RATE IN OPEN WATER RESERVOIRS WERE MEASURED. TRACER STUDIES ON MIXING OF WASTE WATERS WITH SURFACE WATERS ARE DESCRIBED.

NEUTRON SOURCES# WELL LOGGING# TRITIUM
RADIOGRAPHY# FILTRATION# WATER TREATMENT

73W-00-5107

N71-14697. ANNOTATED BIBLIOGRAPHY OF REPORTS, STUDIES, AND INVESTIGATION RELATING TO SATELLITE HYDROLOGY. JULY 1970.
BAKER, DR# FLANDERS, AF# FLEMING, M
COMMERCE DEPT.
N71-14697

32P. THE BIBLIOGRAPHY IS ON APPLICATIONS OF SATELLITE DATA TO HYDROLOGIC PROBLEMS CONFRONTING ESSA'S MISSION.

HYDROLOGY# ARTIFICIAL SATELLITES# BIBLIOGRAPHIES

73W-00-5108

SCI-71-005. CONTINUOUS SYSTEMS SIMULATION BIBLIOGRAPHY. MARCH 1971.
IBM WHITE PLAINS, DPO
SCI-71-005

19P. THIS BIBLIOGRAPHY REPRESENTS A COMPREHENSIVE LIST OF PAPERS, ARTICLES, AND PUBLICATIONS RELATED TO THE IBM CONTINUOUS SYSTEMS MODELING PROGRAMS AND THEIR APPLICATIONS.

COMPUTERIZED SIMULATION# IBM SYSTEM/ 360# IBM1130
BIBLIOGRAPHIES

73W-00-5114

N71-14871. ON THE THEORY OF THE PHOTOGRAPHY OF SINGLE AND MULTIPLE COLORS BY THE INTERFERENCE METHOD. NOVEMBER 1970.
LIPPMAN, MG
GRUMMAN AEROSPACE CORP., BETHPAGE, N.Y.
N71-14871# TR-59

17P. PROFESSOR M.G. LIPPMAN'S INVESTIGATIONS ON COLOR PHOTOGRAPHY, CARRIED OUT BEFORE THE TURN OF THE CENTURY, REPRESENT THE FIRST SUCCESSFUL ATTEMPT TO REPRODUCE COLORS ACCURATELY IN A PHOTOGRAPHIC PROCESS. AS AGAINST THE MODERN PRACTICAL, BUT LESS PERFECT APPROACH, LIPPMAN SUCCEEDED IN CREATING AN ACTUAL COLOR PRESERVATION IN THE PHOTOGRAPHIC EMULSION, BY THE PRODUCTION OF STATIONARY WAVES REPRESENTED BY ALTERNATING DARK AND LIGHT LAYERS WITHIN AND PARALLEL TO THE EMULSION.
THE ARTICLE TRANSLATED HERE FROM THE ORIGINAL FRENCH WRITTEN IN 1894 IS A HISTORICAL ONE. IT DESCRIBES THE FIRST PRACTICAL APPROACH TO COLOR PHOTOGRAPHY; IT MAY ALSO BE CONSIDERED AS THE FIRST ATTEMPT OF CREATING AN IMAGE CLOSELY RESEMBLING THE HOLOGRAPHIC TECHNIQUE DEVELOPED HALF A CENTURY LATER.

COLOR PHOTOGRAPHY# HOLOGRAPHY

73W-00-5115

N71-15409. PHOTOGRAMMETRIC TECHNIQUES APPLICABLE TO EARTH RESOURCES ANALYSES. AUGUST 1971.
LARSEN, PA
GEORGE C. MARSHALL SPACE FLIGHT CENTER, ALA.
N71-15409# NASA-TMX-64546

65P. THE USES OF PHOTOGRAMMETRY AS A TOOL FOR STUDYING OUR NATURAL RESOURCES AND AS AN AID IN UNDERSTANDING AND DEFINING ENVIRONMENTAL PROBLEMS CONFRONTING THE INHABITANTS OF EARTH ARE DISCUSSED. NUMEROUS APPLICATIONS OF PHOTOGRAMMETRY FROM THE PAST ARE CITED, AND SEVERAL VERY RECENT APPLICATIONS ARE DISCUSSED BRIEFLY. ACTUAL MEASUREMENTS OF PHYSICAL FEATURES OF THE EARTH'S AND MOON'S SURFACES, WHICH WERE MADE PHOTOGRAMMETRICALLY ON STEREOGRAMS PREPARED FROM APOLLO 6 AND APOLLO 8 VERTICAL ORBITAL PHOTOGRAPHS, ARE SHOWN. THE SKYLAB EXPERIMENT S-190. SIX CAMERA MULTISPECTRAL PHOTOGRAPHY, IS DISCUSSED, AND A GRAPHICAL ANALYSIS DEALING WITH THE PERCENTAGE OF GROUND OBSERVABLE BY THE SKYLAB CAMERAS AS A FUNCTION OF CUMULUS CLOUD COVERAGE IS PRESENTED.

PHOTOGRAMMETRY# AERIAL PHOTOGRAPHY# GEOGRAPHY
GEOLOGY# METEOROLOGY

73W-00-5116

N71-14802. THE NIMBUS 4 MICHELSON INTERFEROMETER. DECEMBER 1970.
HANEL, RA# SCHLACHMAN, B# ROGERS, D# VANOUS, D
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
N71-14802# NASA-TMX-65395# X-620-70-421

33P. THE DESIGN AND PERFORMANCE OF THE MICHELSON INTERFEROMETER. IRIS-D, ARE DESCRIBED, AND THE DESIGN DIFFERENCES WHICH EXIST BETWEEN THE INTERFEROMETERS FLOWN ON NIMBUS 3 AND 4 ARE DISCUSSED. THE PERFORMANCE IS DEMONSTRATED BY EXAMPLES OF SPECTRA OBTAINED WHILE IN EARTH ORBIT.

INTERFEROMETERS# EMISSION SPECTRA

73W-00-5117

N71-14812. AN OPTICAL INTERFEROMETRIC METHOD TO ELIMINATE THE ATMOSPHERIC DEGRADATION OF RESOLUTION. SEPTEMBER 1970.
CURRIE, DG
MARYLAND UNIV., COLLEGE PARK
N71-14812# AD712717# AFOSR-70-2419TR

8P. THE OBJECTIVE OF THE RESEARCH WAS THE DEVELOPMENT, FABRICATION AND USE OF AN INTERFEROMETER CAPABLE OF MAKING HIGH SPACIAL RESOLUTION MEASUREMENTS THROUGH THE TURBULENT ATMOSPHERE. IN PARTICULAR, A PROTOTYPE OF THE INTERFEROMETER WAS DESIGNED AND FABRICATED, AND THEN TESTED, BOTH IN THE LABORATORY AND ON A TELESCOPE. THE KNOWLEDGE GAINED FROM THE PROTOTYPE (A COUDE MODEL) PERMITTED THE DESIGN OF THE FINAL INTERFEROMETER. THIS INTERFEROMETER (A CASSEGRAIN MODEL) IS NOW BEING FABRICATED. THIS PAPER IS AN ENLARGEMENT AND EXPLANATION OF THE RESULTS PRESENTED IN THE WOODS HOLE PAPER.

INTERFEROMETERS# OPTICAL INTERFEROMETERS

73W-00-5118

N71-14886. DUAL CHANNEL SPECTROMETER FOR ROTATIONAL TEMPERATURE MEASUREMENTS. DECEMBER 1970.
HOOKSTRA, CR# HOPPE, JC# HUNTER, WW
LANGLEY RESEARCH CENTER, HAMPTON, VA.
N71-14886# NASA-TMX-2135# L-6859

14P. A UNIQUE DUAL CHANNEL SPECTROMETER CAPABLE OF MAKING ROTATIONAL TEMPERATURE MEASUREMENT OF LOW DENSITY NITROGEN GAS UP TO 500 K HAS BEEN DEVELOPED AND TESTED. THE INSTRUMENT IMAGES ON A SINGLE VARIABLE WIDTH ENTRANCE SLIT THE FLUORESCENCE OF THE FIRST NEGATIVE SYSTEM OF NITROGEN RESULTING FROM INELASTIC COLLISIONS BETWEEN FAST ELECTRONS AND NITROGEN MOLECULES. THE ROTATIONAL ENERGY INTERVAL OBSERVED BY EACH CHANNEL IS SET BY PRESELECTED EXIT SLIT WIDTHS. THE RATIO OF ROTATIONAL ENERGY WITHIN THE TWO CHANNELS IS THEN A CALCULABLE FUNCTION OF TEMPERATURE.

SPECTROMETERS# TEMPERATURE MEASUREMENT# NITROGEN

73W-00-5131

73W 05131. APPLICATION OF THE STANFORD STREAMFLOW SIMULATION MODEL TO AGRICULTURAL WATERSHEDS. DECEMBER 1969.
RICCA, VT# BRIGGS, DL# BALK, EL# TAIGANIDES, EP
OHIO STATE UNIV., COLUMBUS
PAPER-NO-69-728

19P. HYDROLOGIC DATA FROM THE NORTH APPALACHIAN EXPERIMENTAL WATERSHED IN COSHOCTON, OHIO ARE USED IN A MODIFIED VERSION OF THE STANFORD STREAMFLOW SIMULATION MODEL TO TEST ITS PERFORMANCE ON AGRICULTURAL WATERSHEDS. A CRITICAL ASSESSMENT IS MADE ON THE USE OF THE MODEL FOR SMALL WATERSHEDS.

WATERSHEDS# STREAM FLOW# HYDROLOGY# CLIMATOLOGY
DIGITAL SIMULATION

73W-00-5133

73W 05133. SIMULATING THE EFFECTS OF ENVIRONMENT ON CROP AND OF CROP ON MICROCLIMATE. DECEMBER 1969.
WAGGONER, PE
CONNECTICUT AGRICULTURAL EXPERIMENT STATION
NEW HAVEN
PAPER-NO-69-915

4P. CONCEIVING A CANOPY OF LEAVES AS A LADDER OF CONDUCTORS FOR WATER VAPOR, SENSIBLE HEAT AND CARBON DIOXIDE ALLOWS CALCULATION OF PHOTOSYNTHESIS AND EVAPORATION AS WELL AS MICROCLIMATIC PROFILES OF TEMPERATURE AND CARBON DIOXIDE FROM LOGICAL WEATHER AND PLANT FACTORS.

MICROCLIMATOLOGY# LEAVES /BOTANY/# SIMULATION

73W-00-5151

N69-31809. A STUDY OF THE LAND TYPE. MARCH 1969.
DAVIS, CM
MICHIGAN UNIV., ANN ARBOR
N69-31809# AD685871# AROD-6504.2-E-4# REPT-08055-2-F

96P. THE DOCUMENT GIVES AN HISTORICAL STUDY OF THE LAND TYPE, A COMPOSITE LAND UNIT, AS DEVELOPED AND USED IN THE 1920S AND 1930S. ITS PURPOSE IS TO BRING TOGETHER THE HISTORY AND SCATTERED LITERATURE OF THIS CONCEPT. REVIEWS ARE INCLUDED OF THE LAND SYSTEM AS USED IN AUSTRALIA AND IN ENGLAND. PART OF THE REPORT IS A COMPUTER ANALYSIS OF THE DIGITALIZED LAND SURFACE OF ONE MICHIGAN COUNTY. IT EMPLOYS TEN TRANSFORMATIONS OF THE DIGITALIZED SURFACE IN AN ATTEMPT TO FIND TRANSFORMATIONS WHICH WILL REASONABLY PREDICT THE LAND TYPES THAT WERE MADE YEARS AGO.

LANDFORMS# DIGITAL TECHNIQUES

73W-00-5160

N70-41668. HYDROLOGIC DATA REDUCTION TECHNIQUES AND UNIT CONVERSIONS FOR USE IN THE OGRE, T WAVE, FLIP, AND RAVE FLUID FLOW CODES. MARCH 1970.
KORVER, JA
CALIFORNIA UNIV., BERKELEY
N70-41668# UCRL-50854

8P. METHODS USED TO DETERMINE KH, THE PERMEABILITY THICKNESS PRODUCT FOR A GIVEN LOCATION, FROM HYDROLOGIC TEST DATA ARE DESCRIBED, AND METHODS FOR CONVERTING THE UNITS OF PERMEABILITY TO THE CORRECT DIMENSIONAL FORM FOR USE IN SPECIFIC COMPUTER CODES FOR ANALYZING GROUND WATER FLOW ARE PRESENTED.

HYDROLOGY# GROUND WATER# WATER FLOW

73W-00-5162

N69-28505. BIBLIOGRAPHY OF REMOTE SENSING OF EARTH RESOURCES FOR HYDROLOGICAL APPLICATIONS. NOVEMBER 1968.
LLAVERIAS, RK
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N69-28505# NASA-TMX-61717# NASA-134

75P. THIS PRELIMINARY BIBLIOGRAPHY WAS PREPARED TO ACQUAINT HYDROLOGISTS WITH THE BASIC LITERATURE INVOLVED IN THIS FIELD. SOME OF THE REFERENCES CONCERN SPECIFIC HYDROLOGIC TOPICS OR SPECIFIC REMOTE SENSING METHODS. OTHER REFERENCES ON VEGETATION MAPPING AND GEOLOGY WERE INCLUDED SO THAT THE READER CAN FIND INFORMATION ON THE SELECTION, PROCESSING, AND USE OF REMOTE SENSING DATA IN THESE COGNATE FIELDS. A NUMBER OF METEOROLOGICAL REFERENCES WERE INCLUDED BECAUSE IN MANY REMOTE SENSING APPLICATIONS, ESPECIALLY FROM EARTH ORBITAL SATELLITES, ATMOSPHERIC EFFECTS MUST BE TAKEN INTO ACCOUNT IN INTERPRETING THE VIEWS OF THE EARTH.

REMOTE SENSING# HYDROLOGY# VEGETATION

73W-00-5163

N69-28360. USEFUL APPLICATIONS OF EARTH ORIENTED SATELLITES: HYDROLOGY. 1969.
NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D.C.
N69-28360# NASA-CR-101405

81P. THE FINDINGS AND RECOMMENDATIONS OF A TECHNICAL STUDY GROUP ON THE APPLICATIONS OF SPACE TECHNOLOGY TO HYDROLOGIC PROBLEMS ARE PRESENTED. FOUR HYDROLOGIC OBJECTIVES AMENABLE TO CURRENT SPACE TECHNOLOGY AND PROMISING SUBSTANTIAL IMMEDIATE AND LONG TERM BENEFITS ARE IDENTIFIED: BASIC STUDIES OF THE HYDROLOGIC CYCLE AND LARGE SCALE HYDROLOGICAL SYSTEMS: SNOW AND ICE MAPPING: SURVEYS OF COASTAL HYDROLOGIC FEATURES AND LARGE INLAND LAKES, AND REAL TIME COMMUNICATIONS OF GROUND BASED HYDROLOGIC DATA. A QUALITATIVE EVALUATION IS MADE OF THE BENEFITS TO BE DERIVED FROM A COLLECTION OF MORE AND BETTER HYDROLOGIC DATA AND IMPROVED WEATHER FORECASTING. A COST ESTIMATE ON A HYDROLOGY SATELLITE SYSTEM IS ALSO INCLUDED.

HYDROLOGY# ARTIFICIAL SATELLITES# MAPPING
WEATHER FORECASTING# REAL TIME OPERATIONS

73W-00-5165

N69-25113. LAND FORMS AND RESOURCES IN CENTRAL RAJASTHAN (INDIA): RESULTS OF THE JALOR PILOT SURVEY. JANUARY 1969.
VERSTAPPEN, HT# GHOSE, B# PANDEY, S
INTERNATIONAL INST. FOR AERIAL AND EARTH SCIENCES, DELFT, NETHERLANDS
N69-25113# SERIES B NO. 51

20P. IT IS POINTED OUT TO WHAT EXTENT NATURAL ENVIRONMENTAL FACTORS AFFECT THE UTILIZATION OF THE ARID AND SEMI ARID LANDS OF INDIA. USING THE JALOR AREA IN THE LUNI RIVER BASIN (CENTRAL RAJASTHAN) AS AN EXAMPLE, IT IS DEMONSTRATED THAT THE CLIMATIC GEOMORPHOLOGICAL DEVELOPMENT OF THE AREA HAS LED TO THE FORMATION OF EXTENSIVE LAYERS OF LIME CONCRETIONS OF LOW PERMEABILITY AND TO LARGE SIZED SAND ACCUMULATIONS TO THE WINDWARD OF RESIDUAL HILLS AND HILL COMPLEXES. THIS DEVELOPMENT HAS HAD A LASTING INFLUENCE ON GROUND AND SURFACE WATER CIRCULATION AND THUS ON THE TYPE AND DISTRIBUTION OF THE PRESENT UTILIZATION OF THE LAND. MOST OF THE MAIN LANDFORM UNITS OCCURRING IN CENTRAL RAJASTHAN ARE REPRESENTED IN THE JALOR PILOT SURVEY AREA. THEY ARE BRIEFLY DESCRIBED AND THEIR HYDROLOGICAL CHARACTERISTICS AND AGRICULTURAL VALUES ARE SUMMARIZED.

LANDFORMS# HYDROLOGY# GEOMORPHOLOGY

73W-00-5168

N69-17126. EARTH RESOURCES SATELLITE SYSTEM. 1968.
COMMITTEE ON SCIENCE AND ASTRONAUTICS WASHINGTON, D.C.
N69-17126

32P. DATA ARE PRESENTED IN SUPPORT OF THE EARTH RESOURCES SATELLITE SYSTEM AND THE DEVELOPMENT OF THE EARTH RESOURCES TECHNOLOGY SATELLITE (ERTS). THE SYSTEM IS CONSIDERED TO HAVE THE POTENTIAL FOR MAKING MAJOR CONTRIBUTIONS TO THE SOLUTION OF MANKIND'S FOOD, WATER, AND MINERAL RESOURCE PROBLEMS, AND TO PROVIDE AN OPPORTUNITY FOR ACHIEVING TANGIBLE ECONOMIC RETURNS FROM THE SUBSTANTIAL SPACE PROGRAM EXPENDITURES. THE EXISTING TECHNOLOGICAL BASE FOR AN OPERATIONAL ERTS DESIGN IS REVIEWED, AND THE HISTORY OF THE PROGRAM IS TRACED. SCIENTISTS IN SIX KEY AREAS ARE GENERALLY CONSIDERED TO BE THE MOST IMPORTANT POTENTIAL USERS OF EARTH RESOURCES DATA. THESE AREAS ARE CARTOGRAPHY, AGRICULTURE, FORESTRY, OCEANOGRAPHY, GEOLOGY, AND HYDROLOGY. IT IS STRONGLY RECOMMENDED THAT NASA CONCENTRATE A MUCH LARGER PORTION OF ITS EFFORTS AND RESOURCES ON THIS PROJECT, AND THE LAUNCH SCHEDULE SHOULD BE COMPRESSED IF POSSIBLE.

ARTIFICIAL SATELLITES# RESOURCES# REMOTE SENSING

73W-00-5177

N71-17486 THRU N71-17492. SOVIET BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 245. JANUARY 1971.
JOINT PUBLICATIONS RESEARCH SERVICE, WASHINGTON, D.C.
N71-17486 THRU N71-17492# JPRS-52271

115P. CONTENTS: 1. ASTRONOMY (SEE N71-17487), 2. METEOROLOGY (SEE N71-17488), 3. OCEANOGRAPHY (SEE N71-17489), 4. TERRESTRIAL GEOPHYSICS (SEE N71-17490), 5. UPPER ATMOSPHERE AND SPACE RESEARCH (SEE N71-17491), 6. SUPPLEMENT: WORK OF THE UNDERWATER RESEARCH LABORATORY (SEE N71-17492).

GEOPHYSICS# ASTRONOMY# METEOROLOGY
OCEANOGRAPHY# USSR

73W-00-5178

N71-16510 THRU N71-16516. SOVIET BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 243.
DECEMBER 1970.
JOINT PUBLICATIONS RESEARCH SERVICE, WASHINGTON, D.C.
N71-16510 THRU N71-16516# JPRS-52087

83P. CONTENTS: 1. ASTRONOMY (SEE N71-16511), 2. METEOROLOGY (SEE N71-16512), 3. OCEANOGRAPHY (SEE N71-16513), 4. TERRESTRIAL GEOPHYSICS (SEE N71-16514), 5. UPPER ATMOSPHERE AND SPACE RESEARCH (SEE N71-16515), 6. OPERATIONS OF CHERNOMOR SEALAB: SUPPLEMENT (SEE N71-16516).

GEOPHYSICS# ASTRONOMY# OCEANOGRAPHY
METEOROLOGY# USSR

73W-00-5179

N71-19086. FIRST FIVE YEARS OF THE ENVIRONMENTAL SATELLITE PROGRAM: AN ASSESSMENT. FEBRUARY 1971.
NATIONAL ENVIRONMENTAL SATELLITE CENTER, WASHINGTON, D.C.
N71-19086

35P. EXAMPLES OF THE VARIETY OF DIRECT, CONTINUING BENEFITS TO ENVIRONMENTAL OBSERVATION AND PREDICTION IN THE UNITED STATES AND OVERSEAS ARE REVIEWED. WEATHER FORECAST AND WARNING SERVICES ARE EMPHASIZED, AND MARITIME, HYDROLOGIC, SPACE ENVIRONMENT, AND EARTH MAPPING SERVICES ARE DISCUSSED. A PRIMARY CHARACTERISTIC IS CONSIDERED TO BE THE EFFECTIVENESS OF THE SATELLITE IN PROVIDING INFORMATION, ROUTINELY AND DEPENDABLY, ESPECIALLY OVER OCEANS AND REMOTE LAND AREAS. OTHER IMPORTANT FACTORS ARE IDENTIFIED AS THE RAPIDITY WITH WHICH FORECAST OFFICES RECEIVE WEATHER PHOTOGRAPHS AND CHARTS, THE OVERALL VIEW OF THE EARTH AND ATMOSPHERIC FEATURES, AND THE UTILIZATION OF METEOROLOGICAL SATELLITE DATA BY OTHER NATIONS.

ARTIFICIAL SATELLITES# WEATHER FORECASTING
METEOROLOGICAL DATA# HYDROLOGY# MAPPING

73W-00-5180

N71-14656 THRU N71-14662. SOVIET BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 240. NOVEMBER 1970.
JOINT PUBLICATIONS RESEARCH SERVICE, WASHINGTON, D.C.
N71-14656 THRU N71-14662# JPRS-51760

49P. CONTENTS: 1. ASTRONOMY (SEE N71-14657), 2. METEOROLOGY (SEE N71-14658), 3. OCEANOGRAPHY (SEE N71-14659), 4. TERRESTRIAL GEOPHYSICS (SEE N71-14660), 5. UPPER ATMOSPHERE AND SPACE RESEARCH (SEE N71-14661), 6. SUPPLEMENT: "SOYUZ" COMMAND MODULE (SEE N71-14662).

GEOPHYSICS# ASTRONOMY# OCEANOGRAPHY
METEOROLOGY# USSR

73W-00-5181

N70-29735. THE DEVELOPMENT OF EARTH SCIENCES IN THE USSR: SELECTED ARTICLES, VOLUME 1. JANUARY 1969.
VINOGRADOV, AP
FOREIGN TECH. DIV., WRIGHT PATTERSON AFB, OHIO
N70-29735# AD685004# FTD-MT-24-291-68-VOL-1

332P. CONTENTS: THE EARTH OVERALL: (FIGURE AND GRAVITATIONAL FIELD OF THE EARTH, ROTATION OF THE EARTH, TERRESTRIAL TIDES, GRAVIMETRY, THERMOPHYSICS OF THE EARTH, INTERNAL STRUCTURE OF THE EARTH, GEOMAGNETIC FIELD, SEISMOLOGY, GEOCHEMISTRY, BIOSPHERE); THE EARTHS CRUST AND UPPER MANTLE: (STRATIGRAPHY, METHODS OF THE DETERMINATION OF ABSOLUTE AGE OF ROCKS AND GEOCHRONOLOGY, PALEOMAGNETIC RESEARCHES, LITHOLOGY, PALEOGEOGRAPHY, CONTEMPORARY SLOW MOVEMENTS OF THE EARTHS CRUST, GEOTECTONICS, VOLCANOLOGY, MINERALOGY, PETROLOGY, GEOLOGY OF ORE DEPOSITS, GEOLOGY OF OIL, HYDROGEOLOGY).

GRAVITATION# EARTH ROTATION# SEISMOLOGY# GEOLOGY
EARTH CRUST# CLIMATOLOGY# METEOROLOGY# USSR

73W-00-5185

N70-16857. EXPERIMENTAL TECHNIQUES FOR LEVELS OF HIGH PRECISION USING THE ZEISS NI 2 AUTOMATIC LEVEL. JULY 1969.
BERRY, RM
ARMY DEPT.
N70-16857# AD693804# MP-69-4

28P. INSTRUMENTATION AND TECHNIQUES DEVELOPED BY THE U. S. LAKE SURVEY FOR LEVELS OF HIGH PRECISION ARE DESCRIBED. AUTOMATIC, OR SELF LEVELING ZEISS NI2 INSTRUMENT IS USED WITH PLANE PARALLEL PLATE MICROMETER. SPECIAL TECHNIQUES ARE USED TO COMPENSATE FOR SYSTEMATIC ERRORS UNIQUE TO AUTOMATIC LEVELS. LEVELS CAN BE RUN WITH THESE METHODS TO A TOLERANCE OF 1.5 MILLIMETERS TIMES THE SQUARE ROOT OF THE LENGTH OF THE SECTION IN KILOMETERS.

INSTRUMENTS# LEVELING# WATER FLOW

73W-00-5186

N70-25618. GUIDE TO SOVIET LITERATURE ACCESSIONS IN THE ATMOSPHERIC SCIENCES LIBRARY, AND THE GEOPHYSICAL SCIENCES LIBRARY. AUGUST 1969.
DONEHOO, IA
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, SILVER SPRING, MD.
N70-25618# PB187473T# ESSA-WB-TA-23

72P. THE DOCUMENT PRESENTS TRANSLATED TABLES OF CONTENTS AND ANNOTATIONS, AND ON A SELECTIVE BASIS, AUTHORS' ABSTRACTS, INTRODUCTIONS, SUMMARIES, AND CONCLUSIONS. IT PROVIDES PROMPT DISSEMINATION OF INFORMATION CONCERNING SOVIET CONTRIBUTIONS.

METEOROLOGY# ATMOSPHERIC SCIENCES# GEOPHYSICS DOCUMENTS# USSR

73W-00-5187

N70-28678. STUDY OF THE USE OF AERIAL AND SATELLITE PHOTOGRAMMETRY FOR SURVEYS IN HYDROLOGY. MARCH 1970.
RAMEY, EH
COMMERCE DEPT.
N70-28678# ESSA-TM-NESCTM-14

28P. POSSIBLE APPLICATIONS OF PHOTOGRAMMETRY IN PROBLEMS OF HYDROLOGY ARE DISCUSSED. THE CRITICAL FACTORS IN THE USE OF SATELLITE PHOTOGRAPHS ARE INCLUDED. THE VARIOUS PHYSICAL AND ECONOMIC FACTORS IN THE USE OF AERIAL PHOTOGRAMMETRY ARE ANALYZED IN THE MEASUREMENT OF BOTH SNOW COVER AND SNOW DEPTH. IT WAS CONCLUDED THAT THE REQUIRED ACCURACY CAN BE ATTAINED, BUT SOMETIMES THE COST WOULD BE PROHIBITIVE. THE USE OF AERIAL PHOTOGRAPHY AND OTHER RELATED SENSORS TO SOME OTHER PROBLEMS IN HYDROLOGY ARE CONSIDERED.

PHOTOGRAMMETRY# HYDROLOGY# REMOTE SENSING

73W-00-5200

PB187221. HYDROLOGIC BEHAVIOR OF SELECTED WATERSHEDS IN THE NORTHERN APPALACHIAN REGION. AUGUST 1969.
SOPPER, WE# HIEMSTRA, LA# CREESE, RC# LAVOIE, RA
PENNSYLVANIA STATE UNIV., UNIV. PARK
PB187221

120P. TWO MATHEMATICAL WATERSHED MODELS WERE DEVELOPED: (1) THE HIEMSTRA WATERSHED MODEL TO SIMULATE THE HYDROLOGIC BEHAVIOR OF A SINGLE SMALL WATERSHED; AND (2) RAPHAEL'S MARKOV CHAIN MODEL TO SIMULATE THE HYDROGRAPH OF A COMPLEX LARGE WATERSHED SYSTEM CONSISTING OF 10 INTERCONNECTED SUBWATERSHEDS.

HYDROLOGY# WATER SUPPLY# MATHEMATICAL MODELS

73W-00-5207

SCS-TP-149. A METHOD FOR ESTIMATING VOLUME AND RATE OF RUNOFF IN SMALL WATERSHEDS. JANUARY 1968.
AGRICULTURE DEPT., WASHINGTON, D.C.
SCS-TP-149

61P. THE SOIL CONSERVATION SERVICE (SCS) HAS DEVELOPED CHARTS ES-1026 AND ES-1027 FOR ESTIMATING THE INSTANTANEOUS PEAK DISCHARGE EXPECTED FROM SMALL AREAS. THEY PROVIDE THE PEAK DISCHARGE RATE FOR ESTABLISHING CONSERVATION PRACTICES ON INDIVIDUAL FARMS AND RANCHES AND FOR THE DESIGN OF WATER CONTROL MEASURES IN SMALL WATERSHEDS. THE GRAPHS WERE PREPARED FROM COMPUTATIONS MADE BY AUTOMATIC DATA PROCESSING (ADP). THE LOGIC AND PROCEDURES USED FOR THE ADP COMPUTATION ARE DESCRIBED.

WATERSHEDS# RAINFALL# SURFACE WATER RUNOFF

73W-00-5208

ARS-41-130. COOPERATIVE RUNOFF AND SEDIMENT INVESTIGATIONS ON MEDICINE CREEK WATERSHED IN NEBRASKA. JUNE 1967.
AGRICULTURE DEPT., WASHINGTON, D.C.
ARS-41-130

95P. COMPREHENSIVE DATA WERE COLLECTED DURING THE PERIOD 1951-58 TO DETERMINE THE IMPORTANT WEATHER, SOIL, CHANNEL, GEOMORPHOLOGIC, AND TOPOGRAPHIC FACTORS AS RELATED TO THE DAMAGE CAUSED BY FLOOD, SEDIMENT, AND EROSION IN THE MEDICINE CREEK WATERSHED OF SOUTHWESTERN NEBRASKA.

WATERSHEDS# SURFACE WATER RUNOFF# SEDIMENTS

73W-00-5209

73W 05209. INFLUENCE OF TOPOGRAPHY ON RAINFALL IN WEST VIRGINIA. JUNE 1969.
GRAFTON, CR# DICKERSON, WH
WEST VIRGINIA UNIV., MORGANTOWN

45P. THE FUNDAMENTAL AIM OF THE WATER RESEARCH INSTITUTE IS TO OBTAIN THE KNOWLEDGE NEEDED TO GAIN THE GREATEST BENEFIT FROM THE WATER RESOURCES OF WEST VIRGINIA. THE BULLETIN IS USED TO REPORT THE FINAL RESULTS OF PROJECTS AND PROGRAMS.

RAINFALL# TOPOGRAPHY# CLIMATOLOGY

73W-00-5211

73W 05211. RAINFALL RUNOFF MODELS.
KOHLER, MA
WEATHER BUREAU, WASHINGTON, D.C.

12P. CONTINUING INVESTIGATIONS ON THE APPLICATION OF HYDROLOGIC ACCOUNTING TO RIVER FORECASTING HAVE BEEN DIRECTED LARGELY TOWARD THE DEVELOPMENT OF IMPROVED MODELS FOR THE RUNOFF AND SOIL MOISTURE DEPLETION PHASES OF THE HYDROLOGIC CYCLE. THE SEVERAL MODELS UNDER STUDY ARE DISCUSSED AND EVALUATED.

RAINFALL# SURFACE WATER RUNOFF# MATHEMATICAL MODELS

73W-00-5212

73W 05212. RUNOFF ESTIMATION FOR VERY SMALL DRAINAGE AREAS.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P87-93
VIESSMAN, W
MAINE UNIV., ORONO

ANALYSES OF HYDROLOGIC DATA FROM HIGH INTENSITY SHORT DURATION STORMS ON VERY SMALL DRAINAGE AREAS HAVING VARYING PHYSICAL CHARACTERISTICS INDICATED THAT A 1 MINUTE UNIT HYDROGRAPH COULD BE USED AS THE BASIS FOR GENERATING RUNOFF FROM AN EFFECTIVE RAINSTORM INPUT.

SURFACE WATER RUNOFF# HYDROGRAPHY# HYDROLOGY

73W-00-5213

73W 05213. RECENT TRENDS IN HYDROGRAPH SYNTHESIS.
PROCEEDINGS OF TECHNICAL MEETING 21. 1966. 30P.
COMMITTEE FOR HYDROLOGICAL RESEARCH TNO

THE PAPERS IN THESE PROCEEDINGS WERE THE SUBJECT OF LECTURES DELIVERED AT A TECHNICAL MEETING OF THE COMMITTEE FOR HYDROLOGICAL RESEARCH TNO IN DECEMBER 1965. THIS MEETING WAS ORGANIZED WITH A VIEW TO CONFRONT THE RELATIVELY YOUNG SURFACE WATER HYDROLOGY IN THE NETHERLANDS WITH RECENT DEVELOPMENTS ABROAD. THE PAPERS MAINLY REVIEW THE RECENT LITERATURE, BUT THEY ALSO INCLUDE SOME MATERIAL THAT IS NOT GENERALLY AVAILABLE TO THE AVERAGE WORKER IN THIS FIELD.

HYDROLOGY# HYDROGRAPHY# RAINFALL

73W-00-5220

73W 05220. MULTICAPACITY BASIN ACCOUNTING FOR PREDICTING RUNOFF FROM STORM PRECIPITATION.
JOURNAL OF GEOPHYSICAL RESEARCH. DECEMBER 1962.
P5187-5197.
KOHLER, MA# RICHARDS, MM
WEATHER BUREAU, WASHINGTON, D.C.

AS A RESULT OF VARIATIONS IN SOIL AND SURFACE CHARACTERISTICS, VEGETATIVE COVER, ETC., THE MOISTURE CAPACITY IS HIGHLY VARIABLE FROM POINT TO POINT OVER A RIVER BASIN. THE BASIC PURPOSE OF THE PAPER IS TO DESCRIBE A METHOD OF BASIN ACCOUNTING RATHER THAN THE USE OF SUCH ACCOUNTING TO CORRELATE RAINFALL TO RUNOFF.

RIVER BASINS# RAINFALL# SURFACE WATER RUNOFF

73W-00-5222

73W 05222. EFFECTS OF CLIMATOLOGIC AND BASIN CHARACTERISTICS ON ANNUAL RUNOFF.
WATER RESOURCES RESEARCH. FIRST QTR 1967. P123-130.
MUSTONEN, SE
BOARD OF AGRICULTURE, HELSINKI, FINLAND

CLIMATOLOGIC AND BASIN CHARACTERISTICS AFFECTING THE ANNUAL RUNOFF IN FINLAND ARE SELECTED BY THE ORTHOGONAL REGRESSION METHOD.

SURFACE WATER RUNOFF# CLIMATOLOGY# WATERSHEDS

73W-00-5225

73W 05225. RUNOFF VOLUME PREDICTION FROM DAILY CLIMATIC DATA.
WATER RESOURCES RESEARCH. FEBRUARY 1969. P84-94.
KNISEL, WG# BAIRD, RW# HARTMAN, MA
AGRICULTURE DEPT., WASHINGTON, D.C.

A TWO SOIL MOISTURE RESERVOIR MODEL IS DEVELOPED TO IMPROVE THE ESTIMATE ACCURACY OF A RUNOFF VOLUME PREDICTION MODEL.

SURFACE WATER RUNOFF# CLIMATOLOGY# SOIL WATER

73W-00-5226

73W 05226. PRECIPITATION RUNOFF RELATIONS FOR VERY SMALL SEMIARID RANGELAND WATERSHEDS.
WATER RESOURCES RESEARCH. APRIL 1969. P419-425.
OSBORN, HB# LANE, L
AGRICULTURAL RESEARCH SERVICE, TUCSON, ARIZ.

SIMPLE LINEAR REGRESSION MODELS FOR PREDICTING TOTAL VOLUME OF RUNOFF, PEAK RATE OF RUNOFF, DURATION OF RUNOFF, AND HYDROGRAPH LAG TIME WERE DEVELOPED USING THREE YEARS OF DATA FROM FOUR SMALL (0.56 TO 11.0 ACRES) WATERSHEDS.

SURFACE WATER RUNOFF# WATERSHED# LINEAR REGRESSION

73W-00-5228

73W 05228. GENERALIZATION OF STREAM FLOW CHARACTERISTICS FROM DRAINAGE BASIN CHARACTERISTICS. 1969.
THOMAS, DM# BENSON, MA
GEOLOGICAL SURVEY, WASHINGTON, D.C.

45P. CONTENTS: INTRODUCTION, DESCRIPTION OF STUDY REGIONS, SELECTION OF STREAMFLOW RECORDS FOR ANALYSIS, INDICES OF STREAMFLOW CHARACTERISTICS, DRAINAGE BASIN CHARACTERISTICS, ANALYTICAL METHODS, AND RESULTS.

STREAM FLOW# WATERSHEDS

73W-00-5231

73W 05231. FACTORS THAT INFLUENCE STREAM FLOW IN THE NORTHEAST.
WATER RESOURCES RESEARCH. THIRD QTR. 1966. P371-379.
LULL, HW
U.S. FOREST SERVICE, UPPER DARBY, PA.
SOPPER, WE
PENNSYLVANIA STATE UNIV., UNIV. PARK

AVERAGE ANNUAL AND SEASONAL RUNOFF AND DAILY MEAN DISCHARGES AT SELECTED FLOW DURATIONS OF 137 WATERSHEDS IN THE NORTHEAST U.S. TOTALING LESS THAN 100 SQUARE MILES WERE RELATED TO SELECTED CLIMATIC, TOPOGRAPHIC, AND LAND USE VARIABLES.

STREAM FLOW# GEOMORPHOLOGY

73W-00-5233

BULLETIN NO. 15. A UNIFORM TECHNIQUE FOR DETERMINING FLOOD FLOW FREQUENCIES. DECEMBER 1967.
WATER RESOURCES COUNCIL, WASHINGTON, D.C.
BULLETIN NO. 15

15P. WITH THE GROWING NEED FOR IMPROVED FLOOD PLAIN MANAGEMENT, DESIRABILITY OF A BASIC, UNIFORM METHOD OF ESTABLISHING FLOOD FREQUENCIES FOR GENERAL USE THROUGHOUT THE NATION IS MANIFEST. WITH THIS NEED IN MIND, THE UNIFORM TECHNIQUE FOR DETERMINING FLOOD FLOW FREQUENCIES SET FORTH IN THIS BULLETIN WAS ADOPTED BY THE COUNCIL'S HYDROLOGY COMMITTEE.

FLOOD PLAINS# RIVER BASINS# FLOOD CONTROL

73W-00-5236

73W 05236. FORESTS AND FLOODS IN THE NORTHWESTERN UNITED STATES. SEPTEMBER 1959.
ANDERSON, HW# HOBBA, RL

10P. FLOOD CAUSES CAN BE DETERMINED BY ANALYSIS OF FLOODS FROM WATERSHEDS WITH WIDE DIFFERENCES IN METEOROLOGICAL HAPPENINGS AND IN TOPOGRAPHIC AND GEOLOGICAL CHARACTERISTICS. VARIATIONS IN THESE BRING ABOUT WIDE FLUCTUATIONS IN FLOOD SIZE.

FLOODS# FORESTRY# WATERSHEDS

73W-00-5242

73W 05242. SYMPOSIUM ON ANALYTICAL METHODS IN HYDROLOGY. WASHINGTON, D.C. APRIL 1966..
WATER RESOURCES RESEARCH. THIRD QTR 1967. P805-907.
AMERICAN GEOPHYSICAL UNION

THE EIGHT PAPERS ARE EXPLANATORY DISCUSSIONS OF SOME ANALYTICAL TECHNIQUES IN CURRENT USE IN SURFACE WATER HYDROLOGY. THEY ARE PRESENTED BY THE SURFACE WATER COMMITTEE IN THE HOPE THAT ALL HYDROLOGISTS MAY BENEFIT THROUGH FULLER UNDERSTANDING OF SUCH TECHNIQUES. THE PAPERS PRESENT EXPLANATIONS OF RECENT AND SIGNIFICANT ADVANCES IN HYDROLOGIC ANALYSIS.

HYDROLOGY# SURFACE WATERS

73W-00-5243

73W 05243. INFILTRATION, OVERLAND FLOW, AND SOIL MOVEMENT ON FROZEN AND SNOW COVERED PLOTS.
WATER RESOURCES RESEARCH. FIRST QTR 1967. P145-161.
HAUPT, HF
FORESTRY SCIENCES LABORATORY, MOSCOW,

THIS SMALL PLOT STUDY SHOWS HOW GROUND COVER, FURROWING, AND THE PRESENCE OF FROST IN SOILS OF THE SIERRA NEVADA AFFECT INFILTRATION FROM PROLONGED SIMULATED WINTER RAINS.

FLUID INFILTRATION# FROST# SNOW

73W-00-5244

73W 05244. RELATIONSHIP BETWEEN PRECIPITATION, EVAPORATION, AND RUNOFF IN TROPICAL EQUATORIAL REGIONS.
WATER RESOURCES RESEARCH. FIRST QTR 1967. P163-172.
SOLOMON, S.
SHAWINIGAN ENG. CO., LTD., MONTREAL, CANADA

BOUCHET'S THEORY ON ACTUAL AND POTENTIAL EVAPORATION CAN BE USED AS A BASIS TO DEVELOP SEMIEMPIRICAL RELATIONSHIPS BETWEEN PRECIPITATION, ACTUAL EVAPORATION, AND RADIATION.

73W-00-5245

73W 05245. LINEAR TIME VARYING MODEL OF RAINFALL RUNOFF RELATION.
WATER RESOURCES RESEARCH. APRIL 1969. P426-437.
CHIU, C# BITTLER, RP
PITTSBURGH UNIV., PA.
THE LINEAR TIME VARYING SYSTEM MODEL OF THE RAINFALL RUNOFF RELATION CAN BE REPRESENTED BY A FIRST ORDER, LINEAR DIFFERENTIAL EQUATION WITH TIME VARYING COEFFICIENTS THAT DEPEND ON TWO PARAMETERS.

RAINFALL# SURFACE WATER RUNOFF# HYDROLOGY
LINEAR DIFFERENTIAL EQUATIONS

73W-00-5247

73W 05247. SOME COMMENTS ON THE USE OF FACTOR ANALYSES.
WATER RESOURCES RESEARCH. FIRST QTR. 1967. P213-223.
MATALAS, NC# REIHER, BJ
GEOLOGICAL SURVEY, ARLINGTON, VA.

FACTOR ANALYSIS IS A TECHNIQUE THAT PURPORTS TO EXPLAIN OBSERVED RELATIONS AMONG SEVERAL VARIATES IN TERMS OF SIMPLER RELATIONS THAT PROVIDE INSIGHT INTO THE UNDERLYING STRUCTURE OF THE VARIATES.

FACTOR ANALYSIS# STATISTICS# MULTIVARIATE ANALYSIS

73W-00-5248

73W 05248. FACTOR ANALYSIS IN HYDROLOGY - AN AGNOSTIC VIEW.
WATER RESOURCES RESEARCH. JUNE 1968. P521-527.
WALLIS, JR
IBM YORKTOWN HEIGHTS, RESEARCH

FACTOR ANALYSIS USED AS A NUMERICAL PROCEDURE FOR SCREENING VARIABLES IS A USEFUL AND POWERFUL TOOL FOR HYDROLOGIC ANALYSIS THAT CAN BE EXPECTED TO YIELD EQUATIONS THAT OUTPERFORM OTHERS WHEN USED AS PREDICTORS FOR CONTROL SAMPLES.

FACTOR ANALYSIS# REGRESSION ANALYSIS# HYDROLOGY

73W-00-5249

73W 05249. SENSITIVITY ANALYSIS METHOD OF SYSTEM IDENTIFICATION AND ITS POTENTIAL IN HYDROLOGIC RESEARCH.
WATER RESOURCES RESEARCH. APRIL 1969. P341-349.
VEMURI, V# DRACUP, JA# ERDMANN, RC
ENVIRONMENTAL DYNAMICS, INC., LOS ANGELES, CALIF.
VEMURI, N
BANARIS UNIV., INDIA

THE APPLICABILITY OF THE SENSITIVITY ANALYSIS METHOD TO IDENTIFY BOTH LUMPED AND DISTRIBUTED HYDROLOGIC SYSTEMS WITH DETERMINISTIC OR STATISTICAL INPUT OUTPUT DATA IS DEMONSTRATED.

SENSITIVITY# HYDROLOGY# ALGORITHMS

73W-00-5255

73W 05255. WATERSHED MODELING APPROACH TO EVALUATION OF THE HYDROLOGIC POTENTIAL OF UNIT AREAS. 1965.
ANDERSON, HW
AGRICULTURE DEPT., BERKELY, CALIF.

12P. FACTOR ANALYSIS IS USED IN TESTING THE ADEQUACY OF SAMPLING OF INDEPENDENT VARIABLES; PRINCIPAL COMPONENT REGRESSION ANALYSES ARE USED IN ESTABLISHING PHYSICAL RELATIONS TO SEDIMENT AND SNOW. FACTOR CONTRIBUTIONS AFTER VARIMAX ROTATION ALLOWS IMPROVED INTERPRETATION OF EXPLAINED VARIANCE. APPLICATION OF A MODEL IN EVALUATING FLOOD SOURCES AND THE SEDIMENT POTENTIAL OF UNIT AREAS IS ILLUSTRATED.

WATERSHEDS# HYDROLOGY# FACTOR ANALYSIS

73W-00-5258

73W 05258. USE OF TOPOLOGIC INFORMATION IN PROCESSING DATA FOR CHANNEL NETWORKS.
WATER RESOURCES RESEARCH. JUNE 1970. P932-936.
SMART, JS
IBM YORKTOWN HEIGHTS, RESEARCH

THE BINARY DIGIT REPRESENTATION OF CHANNEL NETWORK TOPOLOGY IS PROPOSED AS AN AID TO DATA HANDLING FOR CHANNEL NETWORKS. EXAMPLES OF ITS USE ARE DRAWN FROM THE FIELDS OF WATER POLLUTION CONTROL AND GEOMORPHOLOGY.

TOPOLOGY# DATA PROCESSING# CHANNELS /WATERWAYS/

73W-00-5262

73W 05262. DISTRIBUTION OF INTERIOR LINK LENGTHS IN NATURAL CHANNEL NETWORKS.
WATER RESOURCES RESEARCH. DECEMBER 1969. P1337-1342.
SMART, JS
IBM YORKTOWN HEIGHTS, RESEARCH

INTERIOR LINK LENGTHS WERE MEASURED FOR 10 CHANNEL NETWORKS WITH MAGNITUDES BETWEEN 80 AND 200. NONPARAMETRIC STATISTICAL METHODS WERE USED TO TEST THE HYPOTHESIS THAT LINK LENGTH IS INDEPENDENT OF LINK MAGNITUDE. FOUR OF THE NETWORKS SHOW NO SIGNIFICANT CHANGE (5 PERCENT LEVEL) OF LINK LENGTH WITH MAGNITUDE. SOME OF THE OTHER NETWORKS DO HAVE SIGNIFICANT CHANGES IN LINK LENGTH, BUT THE EXACT NUMBER DEPENDS ON THE NATURE OF THE ALTERNATIVE HYPOTHESIS. HALF OF THE OBSERVED CHANGES WERE POSITIVE AND HALF WERE NEGATIVE.

CHANNELS /WATERWAYS/# STREAMS

73W-00-5263

73W 05263. STATISTICAL PROPERTIES OF STREAM LENGTHS.
WATER RESOURCES RESEARCH. OCTOBER 1968. P1001-1014.
SMART, JS
IBM YORKTOWN HEIGHTS, RESEARCH

TWO BASIC ASSUMPTIONS ARE EMPLOYED IN THIS TREATMENT OF THE STATISTICS OF STREAM LENGTHS: (1) ALL TOPOLOGICALLY DISTINCT NETWORKS WITH A GIVEN NUMBER OF SOURCES ARE EQUALLY LIKELY, (2) LENGTHS OF INTERIOR LINKS IN A GIVEN NETWORK ARE INDEPENDENT RANDOM VARIABLES DRAWN FROM THE SAME POPULATION.

STREAMS# GEOMORPHOLOGY# WATERSHEDS

73W-00-5264

73W 05264. MEAN STREAM NUMBERS AND BRANCHING RATIOS FOR TOPOLOGICALLY RANDOM CHANNEL NETWORKS.
BULLETIN OF THE INTERNATIONAL ASSOC. OF SCIENTIFIC HYDROLOGY. DECEMBER 1968. P61-64.
SMART, JS
IBM YORKTOWN HEIGHTS, RESEARCH

SHREVE'S FORMULAS FOR TOPOLOGICALLY RANDOM NETWORKS ARE USED TO CALCULATE MEAN STREAM NUMBERS AND MEAN BIFURCATION RATIOS FOR PARTICULAR VALUES OF N SUB 1. THE EXACT VALUES ARE COMPARED WITH THE MONTE CARLO RESULTS OF LIAO AND SCHEIDEGGER.

STREAMS# CHANNELS /WATERWAYS/# TOPOLOGY

73W-00-5266

73W 05266. THE RELATION BETWEEN MAINSTREAM LENGTH AND AREA IN DRAINAGE BASINS.
WATER RESOURCES RESEARCH. FOURTH QTR. 1967. P963-974.
SMART, JS# SURKAN, AJ
IBM YORKTOWN HEIGHTS, RESEARCH

DATA ARE PRESENTED FOR BOTH REAL AND SIMULATED STREAM SYSTEMS. CONCLUSIONS ARE: (1) VARIATION IN MAINSTREAM SINUOSITY WITH AREA CAN BE RESPONSIBLE FOR A SIGNIFICANT PART OF THE DEVIATION OF N PRIME FROM 1/2. (2) THE GENERALLY ACCEPTED STATEMENT THAT DRAINAGE BASINS BECOME MORE ELONGATED AS THEIR AREA INCREASES NEEDS FURTHER INVESTIGATION.

WATERSHEDS# GEOMORPHOLOGY# RIVERS

73W-00-5268

TR-16. LIST OF SAMPLE PARAMETERS OF QUANTITATIVE PROPERTIES OF LANDFORMS: THEIR USE IN DETERMINING THE SIZE OF GEOMORPHIC EXPERIMENTS. 1958.
MELTON, MA
COLUMBIA UNIV., NEW YORK, N.Y.
TR-16

17P. THE LIST OF SAMPLE PARAMETERS PRESENTED HERE PROVIDES ESTIMATES OF VARIANCE, MEANS, AND COEFFICIENTS OF VARIATION FOR POPULATIONS THAT HAVE BEEN STUDIED IN THE RECENT PAST, AND WILL BE OF CONTINUED INTEREST. BRIEF DESCRIPTIONS OF THE GEOLOGIC AND CLIMATIC ENVIRONMENTS FROM WHICH EACH SAMPLE WAS DRAWN WILL ALLOW AN INVESTIGATOR TO SELECT THE SAMPLE MOST NEARLY LIKE HIS OWN EXPERIMENTAL MATERIAL. AS MORE DATA BECOME AVAILABLE, THIS LIST CAN BE GREATLY ENLARGED, THEREBY INCREASING ITS USEFULNESS.

GEOMORPHOLOGY# LANDFORMS

73W-00-5269

73W 05269. HYDROGEOMORPHOLOGY. OCTOBER 1963.
MILLER, CR

15P. GEOMORPHIC AND HYDROGEOMORPHIC FACTORS ARE INHERENTLY INVOLVED IN ANY WATERSHED CONVERVATION OR WATER RESOURCES DEVELOPMENT PROGRAMS.

GEOMORPHOLOGY# WATERSHEDS# MORPHOLOGY

73W-00-5270

TR-17. RELATION OF MORPHOMETRIC PROPERTIES TO RUNOFF IN THE LITTLE MILL CREEK, OHIO, DRAINAGE BASIN. 1959.
MORISAWA, ME
COLUMBIA UNIV., NEW YORK, N.Y.
TR-17

10P. QUANTITATIVE GEOMORPHIC CHARACTERISTICS OF FIVE SUBDIVISIONS OF MILL CREEK WATERSHED, OHIO, WERE CORRELATED WITH HYDROLOGIC DATA. IN SUCH A SMALL HOMOGENEOUS BASIN FACTORS OF CLIMATE, STRUCTURE, LITHOLOGY AND SOIL TYPE ARE ASSUMED TO BE MINIMIZED AS SIGNIFICANT VARIABLES. SIGNIFICANT REGRESSIONS WERE OBTAINED FOR AVERAGE STREAM DISCHARGE ON BASIN AREA, RELIEF RATIO, CIRCULARITY, AND ELONGATION. REGRESSIONS FOR PEAK RUNOFF ON EACH OF THESE MORPHOMETRIC MEASUREMENTS ALSO PROVED TO BE SIGNIFICANT. THESE RELATIONSHIPS MAY PROVE USEFUL IN ESTIMATING STREAM FLOW IN UNGAGED PORTIONS OF DRAINAGE BASINS.

GEOMORPHOLOGY# WATERSHEDS# SURFACE WATER RUNOFF

73W-00-5271

73W 05271. PHYSIOGRAPHIC CHARACTERISTICS AND THE RUNOFF PATTERN. MAY 1964.
GRAY, DM
SASKATCHEWAN UNIV., SASKATOON, CANADA

21P. THE INFLUENCE OF SEVERAL GEOMORPHIC CHARACTERISTICS OF A WATERSHED AS, DRAINAGE AREA SIZE, LENGTH AND SLOPE OF THE MAIN STREAM, GENERAL LAND SLOPE AND CHANNEL GEOMETRY ON THE TIME DISTRIBUTION OF SURFACE RUNOFF IS DISCUSSED. THE PRESENTATION EMPHASIZES THE INTERRELATIONSHIPS BETWEEN CERTAIN GEOMORPHIC PROPERTIES OF A WATERSHED AND DEMONSTRATES THE USE OF THE FACTORS FOR SYNTHESIZING UNIT GRAPHS FOR UNGAGED AREAS. CONSIDERATION IS ALSO GIVEN TO THE EFFECT OF SUCH FACTORS AS CLIMATE TOPOGRAPHY AND VEGETATION THAT DETERMINE THE CHARACTERISTICS OF HYDROGRAPHS FROM MELTING SNOW.

GEOMORPHOLOGY# WATERSHEDS# SURFACE WATER RUNOFF

73W-00-5272

73W 05272. THE SYNTHESIS OF DISTRIBUTED INPUTS FOR HYDROGRAPH PREDICTIONS.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P79-85.
BRAKENSIEK, DL# ONSTAD, CA
AGRICULTURE DEPT., BELTSVILLE, MD.

A SURFACE FLOW MODEL BASED ON KINEMATIC WAVE THEORY IS APPLIED TO A FLOW SYSTEM DERIVED FROM THE GEOMORPHIC PROPERTIES OF THE WATERSHED IN QUESTION.

HYDROLOGY# SURFACE WATER RUNOFF# WATERSHEDS

73W-00-5273

73W 05273. ISOLATION AND CHARACTERIZATION OF HYDROLOGIC RESPONSE UNITS WITHIN AGRICULTURAL WATERSHEDS.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P73-77.
ENGLAND, CB# ONSTAD, CA
AGRICULTURE DEPT., BELTSVILLE, MD.

TO EXTRAPOLATE HYDROLOGIC RELATIONS FROM SMALL TO LARGE AREAS, A WATERSHED CAN BE PARTITIONED BY ISOLATION OF UNITS OF RELATIVE HOMOGENEITY WITH RESPECT TO SOIL TYPE, LANDFORM, AND LAND USE THAT FALL INTO A SEQUENCE COMPATIBLE WITH THE HYDRAULICS OF OVERLAND AND SUBSURFACE FLOWS.

HYDROLOGY# WATERSHEDS# SURFACE WATER RUNOFF

73W-00-5278

TR-11. AN ANALYSIS OF THE RELATIONS AMONG ELEMENTS OF CLIMATE, SURFACE PROPERTIES, AND GEOMORPHOLOGY. 1957.
MELTON, MA
COLUMBIA UNIV., NEW YORK, N.Y.
TR-11

175P. LANDFORM MORPHOMETRY IS RELATED TO CAUSATIVE FACTORS OF CLIMATE, MANTLE CHARACTERISTICS, VEGETATION DENSITY, AND LITHOLOGY. DRAINAGE BASINS ANALYZED ARE IN MATURE FLUVIAL DEVELOPMENT, FREE FROM OBVIOUS STRUCTURAL INFLUENCE, AND IN CLIMATES RANGING FROM ARID TO HUMID. OVER 80 BASINS IN ARIZONA, COLORADO, NEW MEXICO, AND UTAH WERE INSPECTED IN THE FIELD; 22 WERE SUBJECTED TO DETAILED FIELD INVESTIGATIONS.

GEOMORPHOLOGY# LANDFORMS# TOPOGRAPHY

73W-00-5279

73W 05279. HORTONS LAW OF STREAM ORDER NUMBERS AND A TEMPERATURE ANALOG IN RIVER NETS.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P167-171.
SCHEIDEGGER, AE
ILLINOIS UNIV., URBANA

STATEMENTS OF HORTONS LAW IN HORTON, STRAHLER AND CONSISTENT STREAM ORDERING SYSTEMS ARE PRESENTED. A TOPOLOGICAL CHARACTERIZATION OF A HORTON NET IS GIVEN.

RIVERS# GEOMORPHOLOGY

73W-00-5288

73W 05288. THE 3 PARAMETER LOGNORMAL DISTRIBUTION AND ITS APPLICATIONS IN HYDROLOGY.
WATER RESOURCES RESEARCH. APRIL 1970. P505-515.
SANGAL, BP# BISWAS, AK
DEPARTMENT OF ENERGY, MINES AND RESOURCES, OTTAWA, CANADA

THE 3 PARAMETER LOGNORMAL DISTRIBUTION IS A GENERAL SKEW DISTRIBUTION IN WHICH THE LOGARITHM OF ANY LINEAR FUNCTION OF A GIVEN VARIABLE IS NORMALLY DISTRIBUTED.

HYDROLOGY# SKEWED DENSITY FUNCTIONS

73W-00-5289

73W 05289. RUNOFF ESTIMATION FOR VERY SMALL DRAINAGE AREAS.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P87-93.
VIESSMAN, W
MAINE UNIV., ORONO

ANALYSIS OF HYDROLOGIC DATA FROM HIGH INTENSITY SHORT DURATION STORMS ON VERY SMALL DRAINAGE AREAS HAVING VARYING PHYSICAL CHARACTERISTICS INDICATED THAT A ONE MINUTE UNIT HYDROGRAPH COULD BE USED AS THE BASIS FOR GENERATING RUNOFF FROM AN EFFECTIVE RAINSTORM INPUT. PROCEDURES ARE GIVEN FOR ESTIMATING NET STORM INPUTS.

HYDROLOGY# SURFACE WATER FUNOFF# WATERSHEDS

73W-00-5292

73W 05292. COMMENTS ON "COMPUTATION OF OPTIMUM REALIZABLE UNIT HYDROGRAPHS" BY PS EAGLESON, R MEJIA, AND F MARCH.
WATER RESOURCES RESEARCH. FEBRUARY 1968. P212-217.
NASH, JE# O'CONNOR, KM
UNIVERSITY COLLEGE, GALWAY, IRELAND

THIS PAPER PRESENTS A NUMERICAL METHOD OF DERIVING UNIT HYDROGRAPHS FROM COMPLEX EVENTS BY PROGRAMMING A LEAST SQUARES SOLUTION OF THE WIENER HOPF EQUATIONS IN DISCRETE TIME FORM,

HYDROGRAPHY# LEAST SQUARES METHOD

73W-00-5293

73W 05293. STEPS TOWARD A BETTER UNDERSTANDING OF URBAN RUNOFF PROCESSES.
WATER RESOURCES RESEARCH. APRIL 1968. P335-347.
BRATER, EF
MICHIGAN UNIV., ANN ARBOR

THIS PAPER DEALS WITH THE STUDY OF INFILTRATION PROCESSES THAT DETERMINE HOW MUCH OF A RAIN OR SNOW MELT BECOMES STORM RUNOFF.

SURFACE WATER RUNOFF# FLUID INFILTRATION# STORMS

73W-00-5294

73W 05294. A MATHEMATICAL MODEL FOR SIMULATING THE HYDROLOGIC RESPONSE OF A WATERSHED.
WATER RESOURCES RESEARCH. JUNE 1968. P529-539.
HUGGINS, LF# MONKE, EJ
PURDUE UNIV., LAFAYETTE, IND.

A GENERAL MATHEMATICAL MODEL WAS DEVELOPED TO SIMULATE THE SURFACE RUNOFF FROM WATERSHEDS.

HYDROLOGY# WATERSHEDS# SIMULATION
MATHEMATICAL MODELS

73W-00-5295

73W 05295. COMMENTS ON "ANALYSIS OF NONLINEARITIES IN GROUND WATER HYDROLOGY: A HYBRID COMPUTER APPROACH" BY V VEMURI AND JA DRACUP.
WATER RESOURCES RESEARCH. JUNE 1968. P670-688.
THOMAS, RG
UNITED NATIONS, ROME, ITALY

THE PAPER ILLUSTRATES THE RAPID ADVANCES THAT HAVE BEEN MADE IN APPLYING THE NEWER COMPUTER TOOLS TO HYDROLOGIC PROBLEMS.

HYDROLOGY# HYBRID COMPUTERS# DIGITAL COMPUTERS

73W-00-5297

73W 05297. COMMENTS ON PAPER "LINEAR ANALYSIS OF HYDROGRAPHS" BY WD MITCHELL.
WATER RESOURCES RESEARCH. AUGUST 1968. P844-846.
JAMIESON, DG# ONSTAD, CA
AGRICULTURE DEPT., BELTSVILLE, MD.

LINEAR SYSTEMS HAVE SEVERAL PROPERTIES, MOST OF WHICH HAVE BEEN USED TO DEFINE LINEARITY AT ONE TIME OR ANOTHER. HOWEVER, THE FUNDAMENTAL PROPERTY, AND THEREFORE THE DEFINITION, IS THE PRINCIPLE OF SUPERPOSITION.

HYDROLOGY# LINEAR SYSTEMS

73W-00-5298

73W 05298. OPTIMAL TAXING OF WATER POLLUTION.
WATER RESOURCES RESEARCH. OCTOBER 1968. P865-875.
UPTON, C
CHICAGO UNIV., ILL.

WITHIN THE CONTEXT OF THE MODEL, OPTIMAL TAXES ON WATER POLLUTION DO EXIST.

WATER QUALITY# WATER POLLUTION# TAXING

73W-00-5299

73W 05299. UNIFORM FLOOD FREQUENCY ESTIMATING METHODS FOR FEDERAL AGENCIES.
WATER RESOURCES RESEARCH. OCTOBER 1968. P891-908.
BENSON, MA
GEOLOGICAL SURVEY, WASHINGTON, D.C.

LARGE SCALE PLANNING FOR IMPROVED FLOOD PLAIN MANAGEMENT AND EXPANDING WATER RESOURCES DEVELOPMENT HAS MADE IT INCREASINGLY IMPORTANT THAT A CONSISTENT APPROACH BE ADOPTED FOR ESTIMATING FLOOD FREQUENCIES.

FLOODS# RIVERS# STATISTICS

73W-00-5301

73W 05301. THE USE OF A SQUARE GRID SYSTEM FOR COMPUTER ESTIMATION OF PRECIPITATION, T5MPERATURE AND RUNOFF.
WATER RESOURCES RESEARCH. OCTOBER 1968. P919-929.
SOLOMON, SI# CHART, EJ# WOOLLEY, JA# CADOU, C
SHAWINIGAN ENGINEERING CO., LTD., MONTREAL, CANADA

THIS PAPER PRESENTS THE APPLICATION OF THE SQUARE GRID SYSTEM TO THE ESTIMATION OF THE PRECIPITATION, TEMPERATURE, AND RUNOFF DISTRIBUTION IN A LARGE AREA. IT SHOWS HOW THE USE OF THE SYSTEM ENABLES EFFICIENT COMBINATION OF THE METEOROLOGIC AND HYDROLOGIC INFORMATION AVAILABLE IN ASSESSING THE PRECIPITATION, TEMPERATURE, AND RUNOFF DISTRIBUTION.

DIGITAL COMPUTERS# SURFACE WATER RUNOFF# WATERSHEDS

73W-00-5302

73W 05302. SOME COMMENTS ON REGIONALIZATION IN HYDROLOGIC STUDIES.
WATER RESOURCES RESEARCH. DECEMBER 1968. P1361-1374
MATALAS, NC# GILROY, EJ
GEOLOGICAL SURVEY, ARLINGTON, VA.

THIS PAPER EXAMINES THE UTILITY OF REGRESSION ANALYSIS AS A REGIONALIZATION TECHNIQUE.

STATISTICS# SYNTHESIS# HYDROLOGY

73W-00-5320

N67-39649. AGRICULTURAL APPLICATION OF REMOTE SENSING. THE POTENTIAL FROM SPACE PLATFORMS. SEPTEMBER 1967.
FREY, HT
AGRICULTURE DEPT., WASHINGTON, D.C.
N67-39649# NASA-CR-89645

35P. CURRENT RESEARCH AND LITERATURE WERE REVIEWED TO IDENTIFY AGRICULTURAL APPLICATIONS OF REMOTE SENSING BY LOW ALTITUDE SPACE PLATFORMS. EXISTING PHOTOGRAPHIC SENSORS AND PHOTOGRAPH INTERPRETATION TECHNIQUES WERE FOUND TO BE ADEQUATE TO PERFORM A VARIETY OF AGRICULTURAL SURVEY TASKS FROM SPACE PLATFORMS. RECONNAISSANCE SURVEYS OF MAJOR LAND USES, SOILS, WATER BODIES, RANGE CONDITIONS, AND CROPPING PRACTICES ARE TECHNICALLY FEASIBLE. CONSISTENT AND ACCURATE IDENTIFICATION OF CROP SPECIES, ANALYSIS OF CROP VIGOR, AND ESTIMATION OF CROP PRODUCTION ARE NOT CLEARLY FEASIBLE. HOWEVER, SUCH INTERPRETATIONS AS THESE ARE PROBABLE IN SPECIAL SITUATIONS USING PHOTOGRAPHIC METHODS. THE DEVELOPMENT OF NONPHOTOGRAPHIC SENSING AND INTERPRETATION CAPABILITIES MAY RESULT IN SUBSTANTIAL INFORMATION GAINS, PARTICULARLY WHEN USED IN CONJUNCTION WITH PHOTOGRAPHIC IMAGERY. DETAILED SOIL SURVEYS AND LIVESTOCK CENSUSES APPEAR UNATTAINABLE FROM SPACE ALTITUDES BECAUSE OF INADEQUATE RESOLUTION AND INTERPRETATION TECHNIQUES.

REMOTE SENSING# PHOTOGRAPHIC IMAGES
SPACE STATIONS# PHOLOINTERPRETATION

73W-00-5321

N70-13504. A NUMERICAL MODEL FOR THE SIMULATION OF TIDAL HYDRODYNAMICS IN SHALLOW IRREGULAR ESTUARIES. FEBRUARY 1969.
MASCH, FD# SHANKAR, NJ# JEFFREY, M# BRANDES, WA
TEXAS UNIV., AUSTIN
N70-13504# PB184834# HYD-12-6901

135P. WORKING UNDER THE ASSUMPTION OF COMPLETE VERTICAL MIXING, A TWO DIMENSIONAL TIME DEPENDENT MODEL IS DESCRIBED WHICH PROVIDES SPATIAL AND TEMPORAL VARIATIONS OF TIDAL FLOWS AND AMPLITUDES. THE MODEL ACCOUNTS FOR VARIOUS PHYSIOGRAPHIC FEATURES FOUND IN SHALLOW ESTUARIES, VARIABLE INFLOWS, LOW TIDAL ACTION, AND OTHER HYDROLOGIC CHARACTERISTICS. THE MODEL FURTHER PROVIDES FOR THE INCLUSION OF WIND STRESS AND CORIOLIS FORCES.

HYDRODYNAMICS# MATHEMATICAL MODELS# VELOCITY
FINITE DIFFERENCE THEORY# TIDES# ESTUARIES

73W-00-5322

N69-28809. AERIAL PHOTOGRAPHY FOR SHALLOW WATER STUDIES ON THE WEST EDGE OF THE BAHAMA BANKS. NOVEMBER 1968.
CONROD, A# KELLY, M# BOERSMA, A
MIT, CAMBRIDGE
N69-28809# AD684146# RE-42

93P. EXPERIMENTS IN ECOLOGICAL SURVEYING AND SHALLOW WATER RECONNAISSANCE BY AERIAL PHOTOGRAPHY ARE REPORTED. THE BIMINI-CAT CAY AREA IS DESCRIBED IN TERMS OF ITS LARGE SCALE FEATURES, AND THE RESULTS OF SITE SURVEYS VS AERIAL PHOTOGRAPHIC INTERPRETATION ARE DISCUSSED. THE GENERALIZED PROBLEM OF DEPTH PENETRATION IS PRESENTED, AS ARE METHODS OF PHOTOGRAPHIC IMAGE ENHANCEMENT FOR IMPROVED DEPTH PENETRATION AND BOTTOM DETAIL DISCRIMINATION. PHOTOGRAPHIC AND THERMAL INFRARED IMAGERY OF BISCAYNE BAY IS PRESENTED, THOUGH WITH LIMITED DISCUSSION.

SHALLOW WATER# AERIAL PHOTOGRAPHY
PHOTOGRAPHIC IMAGES

73W-00-5323

N69-18523. INTERPRETATION OF AERIAL PHOTOGRAPHS IN THEORY AND PRACTICE (SELECTED ARTICLES). MARCH 1968.
BAKHVALOV, VM# KOLTSOV, VV
FOREIGN TECH. DIV., WRIGHT PATTERSON AFB, OHIO
N69-18523# AD679721# FTD-HT-23-121-68

43P. CONTENTS: 1. ESTIMATION OF THE SPECTRAL BRIGHTNESS OF HAZE AND ITS EFFECT ON THE PHOTO INTERPRETATION OF AERIAL PHOTOGRAPHS 2. SPECTROMETRIC AERIAL PHOTOGRAPHY USING A COMPUTER.

AERIAL PHOTOGRAPHY# ATMOSPHERIC SCATTERING
SPECTROMETERS# SPECTROSCOPY# PHOTOINTERPRETATION

73W-00-5324

N68-17408. THE USE OF MULTISPECTRAL SENSING TECHNIQUES TO DETECT PONDEROSA PINE TREES UNDER STRESS FROM INSECT OR PATHOGENIC ORGANISMS. SEPTEMBER 1967.
HELLER, RC# ALDRICH, RC# WEBER, FP# MC CAMBRIDGE, WF
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION, BERKELEY, CALIF.
N68-17408# NASA-CR-93173# APR-2

73P. BOTH GROUND AND AIRBORNE OPERATIONS WERE CONDUCTED TO IDENTIFY THE LIKELIEST SENSORS AVAILABLE TO FORESTERS TO DETECT EARLY TREE STRESS. AERIAL PHOTOGRAPHY (COLOR AND FALSE COLOR) WAS TAKEN AT FIVE PERIODS (OCTOBER 1966, MAY, JUNE, JULY AND AUGUST 1967) OVER SIX INFESTATION CENTERS TO CAPTURE THE CHANGES IN FOLIAGE COLORATION. OPTICAL MECHANICAL SCANNING IMAGERY WAS OBTAINED IN THREE WAVELENGTHS OVER A THREE DAY PERIOD IN JUNE 1967. BETTER GROUND INSTRUMENTATION WAS DEVELOPED THIS SEASON FOR MEASURING SAP FLOW, EMITTED FOLIAGE TEMPERATURE, AND METEOROLOGICAL CONDITIONS. A PROMISING NEW DEVICE (SCHOLANDER BOMB) MEASURED HIGHLY SIGNIFICANT DIFFERENCES IN NEEDLE MOISTURE TENSION BETWEEN HEALTHY AND STRESSED FOLIAGE. FOLIAGE DISCOLORATION RATES OF ALL 204 INFESTED TREES WERE ESTABLISHED BY COMPARISON WITH MUNSELL CARDS.

REMOTE SENSING# AERIAL PHOTOGRAPHY# FOREST TREES

73W-00-5325

N68-38142. STATUS OF AERIAL COLOR PHOTOGRAPHY IN GOVERNMENT AGENCIES. MAY 1968.
ANSON, A
ARMY ENGINEER TOPOGRAPHIC LABS., FORT BELVOIR, VA.
N68-38142# AD674189# USAETL-TB-1

92P. THE UTILITY OF AERIAL COLOR PHOTOGRAPHY FOR STUDIES IN THE FIELDS OF GEOLOGY, GEOGRAPHY, ARCHAEOLOGY, LANDFORMS, RANGE MANAGEMENT, TARGET DETECTION, HIGHWAY PLANNING, AND HYDROLOGY HAS BEEN RECOGNIZED BY THOSE WHO ARE WORKING IN AERIAL PHOTOGRAPHY; HOWEVER, THE USEFULNESS OF COLOR HAS NOT BEEN DETERMINED ADEQUATELY FOR MILITARY GEOGRAPHIC INTELLIGENCE. THIS REPORT IS A SUMMATION OF RESEARCH INTO THE STATUS OF AERIAL COLOR PHOTOGRAPHY IN SEVERAL GOVERNMENT AGENCIES, AND ITS APPLICATION TO SPECIFIC PROBLEMS.

AERIAL PHOTOGRAPHY# COLOR PHOTOGRAPHY
REMOTE SENSING# TARGET ACQUISITION

73W-00-5326

N68-17406. THE INTERPRETABILITY OF HIGH ALTITUDE MULTISPECTRAL IMAGERY FOR THE EVALUATION OF WILDLAND RESOURCES. SEPTEMBER 1967.
DRAEGER, WC
CALIFORNIA UNIV., BERKELY
N68-17406# NASA-CR-93187

43P. HIGH ALTITUDE MULTISPECTRAL IMAGERY OF THE BUCKS LAKE TEST SITE IN THE SIERRA NEVADA MOUNTAINS OF CALIFORNIA WAS STUDIED, AND FIELD DATA COLLECTIONS WERE MADE IN AN ATTEMPT TO ASCERTAIN THE OPTIMUM SPECIFICATIONS FOR REMOTE SENSING IMAGERY ON WHICH TO IDENTIFY AND EVALUATE WILDLAND RESOURCES. EXAMPLES OF THE INFORMATION THAT CAN BE EXTRACTED FROM VARIOUS TYPES OF SMALL SCALE IMAGERY WERE PREPARED AND DISCUSSED AND A REPRESENTATIVE IMAGE INTERPRETATION GUIDE FOR USE IN TRAINING INTERPRETERS WAS DEVELOPED. OPTIMUM IMAGE SPECIFICATIONS WERE FOUND TO VARY WITH BOTH THE RESOURCE INVOLVED AND THE TYPE OF MANAGEMENT DECISIONS TO BE MADE. IT WAS CONCLUDED, HOWEVER, THAT THE BEST SINGLE IMAGE TYPE FOR GENERAL PURPOSES IS THAT OBTAINED USING EKTA AERO INFRARED FILM IN CONJUNCTION WITH A WRATTEN 12 FILTER.

REMOTE SENSING# INFRARED FILM# IMAGES
INFRARED DETECTORS

73W-00-5327

N69-40203. APOLLO 9 MULTISPECTRAL PHOTOGRAPHY: GEOLOGIC ANALYSIS. SEPTEMBER 1969.
LOWMAN, PD
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
N69-40203# NASA-TMX-63714

57P. THE APOLLO 9 MISSION CARRIED A MULTISPECTRAL TERRAIN PHOTOGRAPHY EXPERIMENT IN WHICH THE ASTRONAUTS PHOTOGRAPHED SELECTED LAND AREAS WITH AN ARRAY OF FOUR 70 MM CAMERAS, EACH WITH A DIFFERENT FILTER/FILM COMBINATION, IN AN EFFORT TO DETERMINE THE FEASIBILITY AND VALUE OF MULTISPECTRAL ORBITAL PHOTOGRAPHY FOR EARTH RESOURCES STUDIES. PRESENTED ARE RESULTS OF A GEOLOGICAL STUDY OF SELECTED SETS MADE TO DETERMINE IF MULTISPECTRAL ORBITAL PHOTOGRAPHY OFFERS ANY ADVANTAGES FOR GEOLOGY OVER COMPARABLE COLOR OR PANCHROMATIC ORBITAL PHOTOGRAPHY. VISUAL COMPARISON OF FOUR CAMERA SETS SHOWED THAT MULTISPECTRAL PHOTOGRAPHY WAS DEFINITELY SUPERIOR IN RENDERING GEOLOGICAL STRUCTURES OF HEAVILY VEGETATED AREAS AND PERMITTED EASY DIFFERENTIATION AMONG DECIDUOUS VEGETATION, OPEN WATER, AND ROCK OR SOIL.

APOLLO PROJECT# SPACEBORNE PHOTOGRAPHY
GEOLOGICAL SURVEYS# TERRAIN INTELLIGENCE

73W-00-5328

N69-28505. BIBLIOGRAPHY OF REMOTE SENSING OF EARTH RESOURCES FOR HYDROLOGICAL APPLICATIONS. NOVEMBER 1968.
LLAVERIAS, RK
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N69-28505# NASA-TMX-61717# NASA-134

75P. THIS PRELIMINARY BIBLIOGRAPHY WAS PREPARED TO ACQUAINT HYDROLOGISTS WITH THE BASIC LITERATURE INVOLVED IN THIS FIELD. SOME OF THE REFERENCES CONCERN SPECIFIC HYDROLOGIC TOPICS OR SPECIFIC REMOTE SENSING METHODS. OTHER REFERENCES ON VEGETATION MAPPING AND GEOLOGY WERE INCLUDED SO THAT THE READER CAN FIND INFORMATION ON THE SELECTION, PROCESSING, AND USE OF REMOTE SENSING DATA IN THESE COGNATE FIELDS. A NUMBER OF METEOROLOGICAL REFERENCES WERE INCLUDED BECAUSE IN MANY REMOTE SENSING APPLICATIONS, ESPECIALLY FROM EARTH ORBITAL SATELLITES, ATMOSPHERIC EFFECTS MUST BE TAKEN INTO ACCOUNT IN INTERPRETING THE VIEWS OF THE EARTH.

REMOTE SENSING# HYDROLOGY# MAPPING# GEOLOGY

73W-00-5329

N70-13062. A SELECTED ANNOTATED BIBLIOGRAPHY ON THE ANALYSIS OF WATER RESOURCE SYSTEMS. AUGUST 1969.
GYSI, M# LOUCKS, DP
CORNELL UNIV., ITHACA, N.Y.
N70-13062# PB186335

197P. PRESENTED IS AN ANNOTATED BIBLIOGRAPHY OF SOME SELECTED PUBLICATIONS PERTAINING TO THE APPLICATION OF SYSTEMS ANALYSIS TECHNIQUES TO WATER RESOURCE PROBLEMS. THE MAJORITY OF THE REFERENCES INCLUDED IN THIS BIBLIOGRAPHY HAVE BEEN PUBLISHED WITHIN THE LAST FIVE YEARS. ABOUT HALF OF THE ENTRIES HAVE INFORMATIVE ABSTRACTS AND KEYWORDS FOLLOWING THE CITATION. INDEX CHARTS GIVE QUICK KEYWORD ACCESS FOR ALL THE REFERENCES, THE ABSTRACTED DOCUMENTS BEING COMPLETELY KEYWORDED, AND THE OTHERS TITLE KEYWORDED.

WATER RESOURCES# BIBLIOGRAPHIES# SYSTEMS ANALYSIS OPTIMIZATION# OPERATIONS RESEARCH

73W-00-5330

N69-15299. PRACTICAL APPLICATIONS OF AERIAL PHOTOGRAPHS IN FORESTRY AND OTHER VEGETATION STUDIES. MARCH 1968.
STELLINGWERF, DA
INTERNATIONAL INST. FOR AERIAL AND EARTH SCIENCES, DELFT, NETHERLANDS
N69-15299# SERIES B NO. 47/48

43P. AERIAL STEROGRAPHS ILLUSTRATING SEVERAL FOREST, CROP, AND SOIL CONDITIONS ARE PRESENTED AND DESCRIBED. BOTH PANCHROMATIC AND INFRARED FILMS WERE USED, ALONG WITH VARIOUS COMBINATIONS OF FILTERS.

AERIAL PHOTOGRAPHS# STEREOPHOTOGRAPHY# FORESTRY

73W-00-5331

N69-28396. EARTH RESOURCES SURVEY PROGRAM: THE REMOTE MEASUREMENT OF RHODAMINE B CONCENTRATION WHEN USED AS FLUORESCENT TRACER IN HYDROLOGIC STUDIES. JANUARY 1968.
BETZ, HT
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N69-28396# NASA-TMX-61713# NASA-101

51P. KNOWLEDGE OF THE TEMPORAL AND SPATIAL DISTRIBUTION OF INJECTED FLUORESCENT TRACER DYES IS USEFUL IN DETERMINING THE MOVEMENT AND DISPERSION OF SOLUBLE CONTAMINANTS IN STREAMS, RIVERS AND ESTUARIES. A STANDARD TECHNIQUE INVOLVES THE INJECTION OF A KNOWN QUANTITY OF DYE AT A SPECIFIC LOCATION AND MONITORING THE RESULTING MOVEMENT AND DISPERSION. DYE CONCENTRATION IS MEASURED WITH A LABORATORY FLUOROMETER, AND IS PLOTTED AS A FUNCTION OF DISTANCE AND TIME. SHIPBORNE TECHNIQUES ARE RELATIVELY SLOW SINCE SAMPLES NEED TO BE TAKEN AND MEASURED OVER DISTANCES OF SEVERAL KILOMETERS OR MORE. ADDITIONALLY, THE SLOWLY VARYING CONCENTRATIONS REQUIRE REPEATED OR PERIODIC SAMPLINGS AT A GIVEN LOCATION SO THAT THE ENTIRE PROCEDURE IS HEAVILY TIME CONSUMING. THE USE OF FIXED SAMPLING LOCATIONS, E.G., BRIDGE OVERPASSES, PROVIDES PRECISE DISTANCE INFORMATION AND VIRTUALLY CONTINUOUS RECORDS OF THE TIME VARYING CONCENTRATION AT A FIXED SITE BUT IS HIGHLY LIMITED IN SPATIAL COVERAGE.

FLUORESCENT DYES# HYDROLOGY# MEASUREMENT

73W-00-5332

N69-12097. NASA GEOLOGICAL TEST SITE NO. 126
MARQUETTE-REPUBLIC TROUGHS, MICHIGAN: REPORT ON PHOTOGRAPHIC IMAGERY OBTAINED ON MISSION 72, MAY, 1968. NOVEMBER 1968.
WHITTEN, EH# BECKMAN, WA# SILVA, ZC
NORTHWESTERN UNIV., EVANSTON, ILL.
N69-12097

15P. CONTINUED INVESTIGATION OF DETERMINING ROCK TYPE, FAULT AND FOLD INFORMATION, AND LOCATION OF GROSS STRUCTURES WITH REMOTE SENSORS IS BRIEFLY REPORTED. ROCK TYPE, FAULTS, LINEAR ELEMENTS, AND SOIL AND VEGETATION WERE DETERMINED BY COLORED PHOTOGRAPHS FROM 2000 FT ALTITUDE. THE INDICATION OF LITHOLOGY WAS LESS CLEAR IN BLACK-AND-WHITE PHOTOGRAPHS THAN IN COLOR, BUT FAULTS, LINEAR STRUCTURES, AND OTHER CHARACTERISTICS APPEARED BETTER.

GEOLOGY# REMOTE SENSING# PHOTOGRAPHIC IMAGES

73W-00-5333

N70-13889. A PLAN FOR A COMPREHENSIVE WATER RESOURCES RESEARCH INFORMATION EXCHANGE SYSTEM. AUGUST 1969.
BANKS, HO# WOLFE, CG
LEEDS, HILL AND JEWETT, INC., SAN FRANCISCO, CALIF.
N70-13889# PB185801

153P. A STUDY WAS MADE OF THE NATURE AND EFFECTIVENESS OF THE PRESENT PROCEDURES USED BY THE OFFICE OF WATER RESOURCES RESEARCH OF THE UNITED STATES DEPARTMENT OF THE INTERIOR AND THE 51 STATE WATER RESOURCES RESEARCH INSTITUTES TO OBTAIN INFORMATION ON PROBLEMS REQUIRING RESEARCH AND TO DISSEMINATE THE RESULTS OF RESEARCH PROJECTS. THE REPORT CONTAINS A RECOMMENDED RESEARCH INFORMATION EXCHANGE SYSTEM IN WHICH THE INFORMATION GATHERING AND DISSEMINATION ACTIVITIES OF OWRR AND THE STATE INSTITUTES WOULD BE BETTER DEFINED AND WOULD BE EXPANDED, AND USE WOULD BE MADE OF THE CAPABILITIES OF FEDERAL INFORMATION DISSEMINATION SERVICES, PROFESSIONAL SOCIETIES, AND OTHER COMMUNICATION MEDIA.

RESEARCH PROJECTS# WATER RESOURCES

73W-00-5334

N69-40545. INTERPRETATION OF GROUND WATER OF TYPICAL LANDSCAPES IN TURKMENIA ON AERIAL PHOTOGRAPHS. JUNE 1969.
MEYER, GY# NEFETOV, KY
ARMY FOREIGN SCIENCE AND TECH. CENTER, WASHINGTON, D.C.
N69-40545# AD691566# FSTC-HT-23-498-68

35P. THE REPORT GIVES A GEOGRAPHICAL DESCRIPTION OF THE NATURAL LANDSCAPES EXISTING IN TURKMENIA AND THE INDIVIDUAL LANDSCAPE ELEMENTS IN THAT SOVIET REPUBLIC: TOPOGRAPHY, CLIMATE, HYDROGRAPHY, SOILS AND CULTURE FEATURES. THE ARTICLE GIVES THE RESULTS OF AERIAL SURVEYS MADE IN THE PRINCIPAL LANDSCAPE TYPES OF TURKMENIA; PARTICULAR ATTENTION IN THIS ARTICLE IS GIVEN TO THE RELATIONSHIP BETWEEN GROUND WATER AND RELIEF, VEGETATION AND SOILS, AND A DESCRIPTION OF WHAT FEATURES SERVE AS INDICATORS OF GROUND WATER AND HOW THESE INDICATORS APPEAR ON AERIAL PHOTOGRAPHS.

PHOTOINTERPRETATION# GROUND WATER# USSR
AERIAL PHOTOGRAPHS

73W-00-5336

N70-11722. STUDY OF THE SPECTRAL BRIGHTNESS OF SOME LANDSCAPE ELEMENTS FOR INTERPRETATION OF GROUND WATER ON AERIAL PHOTOGRAPHS. JUNE 1969.
ARTSYBASHEV, YS
ARMY FOREIGN SCIENCE AND TECH. CENTER, WASHINGTON, D.C.
N70-11722# AD692647# FSTC-HT-23-353-68

38P. THE REPORT PRESENTS EXPERIENCE IN THE STUDY OF THE SPECTRAL REFLECTIVITY OF SOME LANDSCAPE ELEMENTS (PRIMARILY VEGETATION AND SOILS) WHICH ARE GROUND WATER INDICATORS AND DESCRIBES THE USE OF THESE DATA FOR THE HYDROGEOLOGICAL INTERPRETATION OF AERIAL PHOTOGRAPHS. THE STUDIES WERE MADE DURING 1958-1960 IN TWO GEOGRAPHICAL ZONES OF THE SOVIET UNION: DESERT (TURKMENIA) AND SEMI DESERT (CASPIAN LOWLAND). THE METHOD FOR INTERPRETING GROUND WATER DESCRIBED IN THIS PAPER WAS CHECKED BY MAKING SIMILAR STUDIES IN THE FOREST ZONE OF THE NORTHWESTERN REGIONS OF THE USSR.

SPECTROPHOTOMETRY# PHOTOINTERPRETATION# USSR
GROUND WATER# AERIAL PHOTOGRAPHS

73W-00-5337

N69-40218. AERIAL PHOTOGRAPHIC METHOD FOR STUDYING GROUND WATER. 1969.
MEYER, GY
ARMY FOREIGN SCIENCE AND TECH. CENTER, WASHINGTON, D.C.
N69-40218# AD690613# FSTC-HT-23-479-68

17P. THIS PAPER PRESENTS A GENERAL REVIEW OF THE USE OF THE AERIAL PHOTOGRAPHIC METHOD IN THE SEARCH FOR GROUND WATER IN VARIOUS PARTS OF THE SOVIET UNION. THE INDIVIDUAL INDICATORS OF THE PRESENCE OF GROUND WATER SHOWN ON AERIAL PHOTOGRAPHS ARE INDIVIDUALLY DISCUSSED; THESE INCLUDE SUCH FEATURES AS VEGETATION, RELIEF, CULTURE FEATURES AND MANY OTHERS. THE ARTICLE DISCUSSES THE MOST USEFUL SCALES OF PHOTOGRAPHY, CAMERAS, LIGHT FILTERS, AIRCRAFT, PROPER SEASON FOR CONDUCTING THE WORK, MOST SUITABLE WEATHER AND BEST TIME OF DAY. SPECIFIC WORK IN THIS FIELD IS DISCUSSED, PARTICULARLY THAT DONE IN TURKMENIA AND THE CASPIAN LOWLAND, BUT THIS IS ALSO CONTRASTED WITH WORK DONE IN OTHER LANDSCAPE REGIONS OF THE COUNTRY. THE VARIOUS CRITERIA USED IN DIFFERENT REGIONS OF THE USSR ARE LISTED. SPECIFIC ASPECTS OF THE FIELD WORK WHICH SUPPLEMENTS AERIAL PHOTOGRAPHY ARE IN SOME DETAIL. THE SIGNIFICANT ROLE OF THE GEOBOTANICAL METHOD IS DISCUSSED, FOLLOWED BY SOME COMMENTS ON THE PREPARATION OF INTERPRETATION KEYS AND PHOTOMOSAICS AND THE ROLE PLAYED BY BLACK AND WHITE AND COLOR PRINTS.

GROUND WATER# AERIAL PHOTOGRAPHS# USSR

73W-00-5338

N69-28326. PRELIMINARY REMOTE SENSING OF THE DELAWARE ESTUARY. OCTOBER 1968.
PAULSON, RW
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N69-28326# NASA-TMX-61716# NASA-128

35P. POTENTIAL APPLICATIONS OF REMOTE SENSING TECHNIQUES FOR ESTUARINE HYDROLOGY HAVE BEEN REVEALED BY AN ANALYSIS OF INFRARED IMAGERY AND AERIAL PHOTOGRAPHY OF THE DELAWARE ESTUARY. IT IS CLEAR THAT INFRARED IMAGERY CAN BE AN IMPORTANT ESTUARINE RECONNAISSANCE TOOL. IN ADDITION, THE ANALYSIS INDICATES THAT ESTUARINE CIRCULATION, REAERATION, AND DISPERSION MIGHT BE EFFECTIVELY STUDIED WITH REMOTE SENSORS.

REMOTE SENSING# ESTUARIES# INFRARED DETECTION
AERIAL PHOTOGRAPHY

73W-00-5339

N68-28636. A GEMINI MOSAIC ALONG THE THIRTY SECOND DEGREE OF LATITUDE FROM BAJA CALIFORNIA TO CENTRAL TEXAS. JUNE 1968.
MACKALLOR, JA
GEOLOGICAL SURVEY, WASHINGTON, D.C.
N68-28636# NASA-CR-95478

15P. A SERIES OF 39 OVERLAPPING PHOTOGRAPHS OF THE SOUTHWESTERN UNITED STATES AND ADJACENT AREAS OF MEXICO WAS OBTAINED AS PART OF AN EXPERIMENT OF THE GEMINI 4 MISSION. TWENTY-FOUR OF THESE PICTURES PLUS ONE FROM THE GEMINI 3 AND FOUR FROM THE GEMINI 5 MISSION WERE USED TO CONSTRUCT A 1:1,000,000 SCALE, BLACK AND WHITE, SEMICONTROLLED MOSAIC. THIS MOSAIC COVERS ABOUT 150,000 SQUARE MILES AND EXTENDS ALONG THE 32D PARALLEL OF NORTH LATITUDE FROM THE PACIFIC OCEAN TO THE 100TH MERIDIAN IN WEST CENTRAL TEXAS, AND AVERAGES ABOUT 150 MILES IN WIDTH. MANY OF THE INDIVIDUAL RECTIFIED PHOTOGRAPHS CAN BE ENLARGED TO A SCALE OF 1:250,000 WITH LITTLE OR NO LOSS OF RESOLUTION; SUCH ENLARGEMENTS WILL BE OF GREAT VALUE TO EARTH RESOURCES STUDIES.

MOSAIC MAPPING# RESOURCES

73W-00-5340

N69-14450. AN APPROACH TO THE REMOTE DETECTION OF EARTH RESOURCES IN SUB ARID LANDS. DECEMBER 1968.
POUQUET, J
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
N69-14450# NASA-TND-4647

26P. THE PURPOSE WAS TO FIND A BETTER GEOLOGICAL TOOL UTILIZING THE NIGHTTIME INFRARED RADIATIONS EMITTED BY THE GROUND, AND THEREBY OBTAIN A BETTER KNOWLEDGE OF THE AGRICULTURAL POSSIBILITIES OF ARID AND SUB-ARID LANDS. THE EQUIVALENT BLACK BODY TEMPERATURES DERIVED FROM NIMBUS 2 HIGH RESOLUTION INFRARED RADIOMETER WERE ANALYZED FOR ALL AVAILABLE ORBITS FROM MAY UNTIL MID NOVEMBER 1966. FROM THIS PRELIMINARY STUDY CERTAIN PREDOMINANT FEATURES EMERGED AND WERE USED AS A BASIS FOR THE INTERPRETATION OF DATA. FOR THE FINAL INTERPRETATION ONLY A FEW EXAMPLES WERE SELECTED: DEATH VALLEY AND SURROUNDINGS, AND SALTON SEA-COLORADO RIVER REGION.

REMOTE SENSING# INFRARED RADIATION# ARID LAND

73W-00-5341

N68-11714. GEOLOGIC APPLICATIONS OF ORBITAL PHOTOGRAPHY. DECEMBER 1967.
LOWMAN, PD
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
N68-11714# NASA-TND-4155

42P. THE POTENTIAL GEOLOGIC APPLICATIONS OF ORBITAL PHOTOGRAPHY (PHOTOGRAPHY OF THE SURFACE OF THE EARTH OR SIMILAR BODIES FROM ORBITING SPACECRAFT) WITH ILLUSTRATIONS FROM VARIOUS GEMINI FLIGHTS ARE SUMMARIZED.

SPACEBORNE PHOTOGRAPHY# GEOLOGY# MAPPING

73W-00-5342

N69-40998. GEOLOGIC APPLICATIONS OF EARTH ORBITAL SATELLITES. JUNE 1968.
PECORA, WT
GEOLOGICAL SURVEY, WASHINGTON, D.C.
N69-40998# A/CONF34/4.1# 68-95441

22P. ANALYSES OF GEMINI PHOTOGRAPHS ILLUSTRATE SEVERAL QUALITIES UNIQUE TO ORBITAL PHOTOGRAPHY THAT ARE OF IMPORTANCE TO GEOLOGISTS AND OTHER SCIENTISTS IN ASSESSING NATURAL RESOURCES.

EARTH ORBITS# ARTIFICIAL SATELLITES# GEOLOGY
SPACEBORNE PHOTOGRAPHY

73W-00-5343

N69-28376. EARTH RESOURCES SURVEY PROGRAM: COMPARISON OF A UV SCANNER/PHOTOMULTIPLIER WITH AN IMAGE ORTHICON. OCTOBER 1967.
GOLDMAN, H# MARSHALL, R
IIT RESEARCH INST., CHICAGO, ILL.
N69-28376# NASA-TMX-61710# NASA-97

18P. A ROTATING MIRROR CAMERA USING A CSTE CATHODE WAS COMPARED TO AN ORTHICON SYSTEM USING A SIMILAR CATHODE. THE ROTATING CAMERA SYSTEM OFFERS A HIGHLY SATISFACTORY SIGNAL TO NOISE RATIO WHEN USING A CSTE PHOTOCATHODE (PLUS FILTER) AT AIRCRAFT ALTITUDES OF ABOUT 2 KM UNDER CLEAR, MID DAY ILLUMINATION CONDITIONS. THE IMAGE ORTHICON APPEARS TO OFFER SIGNAL TO NOISE RATIOS THAT ARE ABOUT 25 TIMES BETTER THAN THOSE OF A ROTATING MIRROR CAMERA OR LINE SCANNER USING A PHOTOMULTIPLIER TUBE. THE ADVANTAGE COMES ABOUT FROM THE SIGNAL INTEGRATION CAPABILITY THAT IMAGE ORTHICONS POSSESS. THIS MAY BE SOMEWHAT TEMPERED BY THE NOTED FRAGILE CHARACTER OF SUCH TUBES PLUS THE ADDITIONAL COMPLEXITY OF EQUIPMENT. FOR AIRCRAFT USE FURTHER INVESTIGATION OF THESE FACTORS IS INDICATED.

ROTATING MIRROR CAMERAS# ORTHICONS# PHOTOMULTIPLIERS

73W-00-5344

N68-19214. VEGETATION ANALYSIS WITH RADAR IMAGERY. APRIL 1966.
MORAIN, SA# SIMONETT, DS
KANSAS UNIV., LAWRENCE
N68-19214# NASA-CR-75170# CRES-61-9

21P. THIS PAPER PRESENTS VEGETATION MAPS PREPARED FROM RADAR IMAGERY OBTAINED OVER SEVERAL CLIMATIC ENVIRONMENTS. THE MAPS AND IMAGERY HAVE BEEN COMPARED WITH EACH OTHER TO DETERMINE THE TYPES OF INFORMATION EXTRACTABLE. CONVENTIONAL VEGETATION MAPS WERE EMPLOYED TO AID IN THE COMPARISON. EMPHASIS WAS ON THE K BAND AND AN/APQ-56 RADAR SYSTEMS.

VEGETATION# MAPPING# RADAR

73W-00-5345

N69-10663. PHOTOGRAPH OF THE EARTH FROM AIS ZOND-5. OCTOBER 1968.
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
N69-10663# NASA-CR-97577# ST-PR-LPS-10767

4P. SPACECRAFT ZOND 5 PHOTOGRAPHS OF THE EARTH FROM OUTER SPACE DURING THE FINAL PORTION OF THE TRAJECTORY SHOW THE WELL DEFINED OUTLINES OF REGIONS AROUND THE MEDITERRANEAN, BLACK, CASPIAN, AND ARAL SEAS; ARABIAN PENINSULA; IRANIAN HIGHLANDS; AND THE GREATER PART OF AFRICA. A CONSIDERABLE PART OF THE EARTH'S SURFACE IS HIDDEN BY CLOUDS.

SPACEBORNE PHOTOGRAPHY# EARTH /PLANET/# USSR

73W-00-5346

N69-15856. REMOTE SENSING OF CHANGES IN MORPHOLOGY AND PHYSIOLOGY OF TREES UNDER STRESS. SEPTEMBER 1968.
OLSON, CE# WARD, JM
MICHIGAN UNIV., ANN ARBOR
N69-15856#*NASA-CR-99183# APR-2

41P. GREENHOUSE WORK WITH TREE SEEDLINGS EXPOSED TO VARYING CONCENTRATIONS OF NACL AND CACL SUB 2 INDICATES THAT THE OAK SPECIES TESTED ARE MORE RESISTANT TO SALT INJURY THAN ASPEN, TULIP POPULAR, MAPLE, OR WILLOW; AND THAT SALT TOLERANCES OF THESE SPECIES DECREASES IN THE ORDER LISTED. DROUGHT CONDITIONS IN SUGAR MAPLE SEEDLINGS, CREATED BY VARYING THE FREQUENCY OF WATERING, WERE ACCOMPANIED BY INCREASING FOLIAR REFLECTANCE OF THE STRESSED PLANTS AT ALL WAVELENGTHS FROM 0.5 TO 2.5 MICROMETERS. PREVISUAL DETECTION OF DROUGHT OR SALT STRESS WAS NOT ACHIEVED USING COLOR OR INFRARED COLOR PHOTOGRAPHY IN THE LABORATORY. FIELD TESTS OF INFRARED SCANNING SYSTEMS FOR DETECTING MOISTURE STRESS IN MATURE TREES WERE ALSO BEGUN.

REMOTE SENSING# INFRARED PHOTOGRAPHY
INFRARED SCANNERS# TREES /PLANTS/

73W-00-5347

N69-12276. GEOLOGICAL EVALUATION OF INFRARED IMAGERY, EASTERN PART OF YELLOWSTONE NATIONAL PARK, WYOMING AND MONTANA. DECEMBER 1968.
SMEDES, HW
GEOLOGICAL SURVEY, WASHINGTON, D.C.
N69-12276# NASA-CR-97813# NASA-83

48P. INFRARED IMAGERY OF PART OF YELLOWSTONE NATIONAL PARK WAS STUDIED TO EVALUATE ITS USEFULNESS IN THE REMOTE SENSING OF GEOLOGIC ENVIRONMENT. APPLICATIONS OF INFRARED IMAGERY TO GEOLOGY AND GEOMORPHOLOGY WERE STUDIED BY DETERMINING WHETHER ROCK AND SOIL TYPES, STRUCTURES, AND THERMAL SPRINGS NOT OBSERVED ON THE GROUND OR FROM CONVENTIONAL AERIAL PHOTOGRAPHS COULD BE DETECTED FROM THIS IMAGERY. THIS REPORT IS PRIMARILY CONCERNED WITH INFRARED IMAGERY OF AREAS UNDERLAIN BY THE EARLY CENOZOIC VOLCANICS; IT INVOLVES THE EASTERN THIRD OF THE PARK AND THE WASHBURN RANGE IN THE NORTH CENTRAL PART OF THE PARK.

REMOTE SENSING# INFRARED DETECTION# GEOLOGY

73W-00-5348

N68-22261. CURRENT PROGRAM AND CONSIDERATIONS OF THE FUTURE FOR EARTH RESOURCES SURVEY. APRIL 1968.
NEWELL, HE
NASA, WASHINGTON, DC
N68-22261

17P. AN OVERVIEW IS PRESENTED ON THE ADVANCES IN SATELLITE SENSING PROGRAMS DURING THE 1962-1968 PERIOD, AND CURRENT NEEDS AND PROBLEM AREAS ARE ASSESSED. PROGRESS IN ESTABLISHING AN OPERATIONAL METEOROLOGICAL SATELLITE PROGRAM IS DISCUSSED, WITH MAJOR ACHIEVEMENTS CITED AS THE AUTOMATIC PICTURE TRANSMISSION SYSTEMS INITIATED WITH TIROS 8, HIGH RESOLUTION INFRARED IMAGERY ALLOWING NIGHTTIME CLOUD COVER MAPPING INTRODUCED WITH NIMBUS 1, SPIN STABILIZATION IN SUN SYNCHRONOUS ORBIT ACHIEVED WITH TIROS 10, THE OPERATIONAL ADVANCED VIDICON CAMERA SYSTEM OF ESSA 2, AND THE SYNCHRONOUS ORBITAL SATELLITE ATS-1. THE GEODETIC SATELLITE PROGRAM IS REVIEWED, ALONG WITH THE APPLICATION OF REMOTE SENSING TECHNIQUES IN THE FIELD OF OCEANOGRAPHY. DATA REQUIREMENTS ARE IDENTIFIED FOR STUDIES ON FORESTRY, AGRICULTURE, GEOGRAPHY, HYDROLOGY, AND GEOLOGY. FUTURE PLANS ARE OUTLINED, AND THE NEED OF PROVIDING A DATA HANDLING AND DISTRIBUTION NETWORK, AND OF ORGANIZING IT INTO AN OVERALL WORKABLE SYSTEM, IS STRESSED.

REMOTE SENSING# ARTIFICIAL SATELLITES

73W-00-5349

N69-40906. EARTH RESOURCES SURVEYS: AN OUTLOOK TO THE FUTURE. FEBRUARY 1969.
KARTH, JE
U.S. CONGRESS
N69-40906

10P. A HISTORY OF THE EARTH RESOURCES SATELLITE PROGRAM (ERS) IS PRESENTED. THE VARIOUS PROBLEMS ENCOUNTERED IN DEVELOPING UNMANNED SPACECRAFT AS OPPOSED TO THE APOLLO APPLICATIONS PROGRAM ARE DISCUSSED.

ARTIFICIAL SATELLITES# REMOTE SENSING

73W-00-5352

NASA-SP-193. EVALUATION OF MOTION DEGRADED IMAGES. DECEMBER 1968.
ELECTRONICS RESEARCH CENTER, CAMBRIDGE, MASS.
NASA-SP-193

192P. THE NECESSITY OF DEALING WITH MOTION DEGRADED IMAGES HAS BEEN WITH US FOR A LONG TIME. AS NEW PROBLEMS HAVE ARISEN, THE SCIENCE AND TECHNOLOGY FOR DEALING WITH THEM HAVE ADVANCED. IN RECENT YEARS, AEROSPACE APPLICATIONS HAVE CREATED REQUIREMENTS FOR THE ULTIMATE IN UNDISTORTED IMAGING UNDER NOVEL OPERATING CONDITIONS.

PHOTOGRAPHIC IMAGES# IMAGE PROCESSING# MOTION
ELECTROOPTICS# ATMOSPHERIC MOTION# HOLOGRAMPS
TURBULENCE

73W-00-5356

73W 05356. GEOLOGICAL SURVEY RESEARCH 1970: CHAPTER D. 1970.
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 700-D

317P. THIS COLLECTION OF 45 SHORT PAPERS IS THE THIRD PUBLISHED CHAPTER OF "GEOLOGICAL SURVEY RESEARCH 1970." THE PAPERS REPORT ON SCIENTIFIC AND ECONOMIC RESULTS OF CURRENT WORK BY MEMBERS OF THE GEOLOGIC, WATER RESOURCES, AND TOPOGRAPHIC DIVISIONS OF THE U.S. GEOLOGICAL SURVEY.

GEOLOGICAL SURVEYS# HYDROLOGY# TOPOGRAPHIC SURVEYS

73W-00-5358

73W 05358. PREDICTION OF WATER YIELD IN HIGH MOUNTAIN WATERSHEDS BASED ON PHYSIOGRAPHY. AUGUST 1967.
JULIAN, RW# YEVJEVICH, V# SEYTOUX, HJ
COLORADO STATE UNIV., FORT COLLINS

22P. THE PRESENT STUDY IS PART OF A MORE COMPREHENSIVE PROJECT WHICH HAS AS ONE OF ITS OBJECTIVES THE DETERMINATION OF CRITERIA, METHODS AND PROCEDURES TO BE USED IN SELECTING DRAINAGE BASINS SUITABLE FOR ATMOSPHERIC WATER RESOURCES PROGRAMS.

WATERSHEDS# HYDROLOGY# GEOMORPHOLOGY

73W-00-5360

73W 05360. SHORT TERM STREAMFLOW FORECASTING FOR HYDRO PLANT OPERATIONS.
COOPER, AJ
TVA, KNOXVILLE, TENN.

29P. THE PRIMARY PURPOSE OF STREAMFLOW FORECASTS IS TO PROVIDE A BASE FOR PLANNING THE OPERATION OF THE RESERVOIRS SO THAT FLOODS CAN BE REGULATED ANY TIME THEY MAY OCCUR.

STREAM FLOW# HYDROELECTRIC POWER GENERATION
HYDROLOGY# WATERSHEDS# FORECASTING

73W-00-5361

73W 05361. ESTIMATING COEFFICIENTS FOR STORAGE FLOOD ROUTING.
JOURNAL OF GEOPHYSICAL RESEARCH. DECEMBER 1963.
P5471-6474.
BRAKENSIEK, DL
AGRICULTURE DEPT., BELTSVILLE, MD.

STORAGE FLOOD ROUTING IS A METHOD FOR PREDICTING FLOOD WAVE PROPAGATION IN A STREAM. IT IS BASED PRIMARILY ON THE EQUATION OF CONTINUITY. FLOW AT A SECTION IS ASSUMED TO BE A SINGLE VALUED FUNCTION OF THE FLOW AREA. ADDITIONAL ASSUMPTIONS ARE USED TO DEVELOP A LINEAR RELATIONSHIP BETWEEN REACH STORAGE AND REACH INFLOW AND OUTFLOW. THE RELATIONSHIP DEFINES TWO COEFFICIENTS WHICH CORRESPOND TO THE X AND K OF THE MUSKINGUM FORMULATION FOR REACH STORAGE. SEVERAL ESTIMATING PROCEDURES ARE DEVELOPED AS A CONSEQUENCE OF THE DERIVED RELATIONSHIPS.

WAVE PROPAGATION# FLOOD ROUTING# FORECASTING

73W-00-5362

73W 05362. RECURRENCE INTERVALS BETWEEN EXCEEDANCES OF SELECTED RIVER LEVELS. 2 - ALTERNATIVES TO A MARKOV MODEL.
WATER RESOURCES RESEARCH. FEBRUARY 1969. P268-275.
MCGILCHRIST, CA
UNIVERSITY OF NEW SOUTH WALES, AUSTRALIA

IT IS SHOWN THAT THE GENERAL RELATIONSHIP BETWEEN THE EXPECTED RECURRENCE INTERVAL AND THE RETURN PERIOD FOR THE ANNUAL MAXIMUM SERIES DEPENDS ON THE CHOICE OF MODEL.

RIVERS# PROBABILITY THEORY

73W-00-5364

73W 05364. GENERALIZATION OF STREAMFLOW CHARACTERISTICS FROM DRAINAGE BASIN CHARACTERISTICS. 1970.
THOMAS, DM# BENSON, MA
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 1975

55P. DEFINITION OF THE NATURAL STREAMFLOW IN ALL STREAMS, GAGED OR UNGAGED, IS ONE OF THE PRINCIPAL OBJECTIVES OF THE STREAMFLOW DATA COLLECTION PROGRAM OF THE GEOLOGICAL SURVEY. THIS REPORT DESCRIBES THE RESULTS OF USING STATISTICAL MULTIPLE REGRESSION ANALYSES TO PROVIDE A GENERALIZED DEFINITION OF THE NATURAL STREAMFLOW IN FOUR WIDELY SEPARATED REGIONS OF THE EASTERN, CENTRAL, SOUTHERN, AND WESTERN AREAS OF THE CONTERMINOUS UNITED STATES.

WATERSHEDS# STREAM FLOW# REGRESSION ANALYSIS

73W-00-5368

73W 05368. THE VARYING SOURCE AREA OF STREAM FLOW FROM UPLAND BASINS. AUGUST 1970.
HEWLETT, JD# NUTTER, WL
GEORGIA UNIV., ATHENS

13P. THE VARIABLE SOURCE AREA CONCEPT OF UPLAND STREAMFLOW MAY SOON BECOME A WORKING MODEL TO ACCOUNT FOR THE VARIOUS SOURCES, PATHWAYS, AND TIMING DELAYS WHICH UNDERLIE THE DYNAMICS OF DISCHARGE FROM HEADWATER AREAS.

STREAM FLOW# WATERSHEDS# SURFACE WATER RUNOFF

73W-00-5370

73W 05370. HYDROGRAPHIC AND SEDIMENTATION SURVEY OF KAJAKAI RESERVOIR, AFGHANISTAN. 1970.
PERKINS, DC# CULBERTSON, JK
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 1608-M

37P. A HYDROGRAPHIC AND SEDIMENTATION SURVEY OF BAND-E KAJAKAI (KAJAKAI RESERVOIR) ON THE DARYA-YE HIRMAND (HELMAND RIVER) WAS CARRIED OUT DURING THE PERIOD SEPTEMBER THROUGH DECEMBER 1968. UNDERWATER MAPPING TECHNIQUES WERE USED TO DETERMINE THE RESERVOIR CAPACITY AS OF 1968. SEDIMENT RANGE LINES WERE ESTABLISHED AND MONUMENTED TO FACILITATE FUTURE SEDIMENTATION SURVEYS.

HYDROGRAPHIC SURVEYS# SEDIMENTATION# RESERVOIRS

73W-00-5371

73W 05371. OUTLINE OF GROUND WATER HYDROLOGY. 1969.
MEINZER, OE
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 494

71P. CONTENTS: (1) WATER OF THE EARTH, (2) ATMOSPHERIC WATER, (3) SURFACE WATER, (4) SUBSURFACE WATER, AND (5) WELLS.

HYDROLOGY# WATER# SURFACE WATERS
WATER WELLS# GROUND WATER

73W-00-5372

73W 05372. TECHNIQUES OF WATER RESOURCES INVESTIGATIONS OF THE U.S. GEOLOGICAL SURVEY. BOOK 7: AUTOMATED DATA PROCESSING AND COMPUTATIONS. CHAPTER C1: A DIGITAL MODEL FOR AQUIFER EVALUATION. 1970.
PINDER, GF
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.

18P. THE SERIES OF MANUALS ON TECHNIQUES DESCRIBES PROCEDURES FOR PLANNING AND EXECUTING SPECIALIZED WORK IN WATER RESOURCES INVESTIGATIONS. THE MATERIAL IS GROUPED UNDER MAJOR SUBJECT HEADINGS CALLED BOOKS AND FURTHER SUBDIVIDED INTO SECTIONS AND CHAPTERS; SECTION C OF BOOK 7 IS ON COMPUTER PROGRAMS.

AQUIFERS# DATA PROCESSING# DIGITAL COMPUTERS
WATER RESOURCES

73W-00-5373

73W 05373. AN ADVANTAGEOUS, ALTERNATIVE PARAMETERIZATION OF ROTATIONS FOR ANALYTICAL PHOTOGRAMMETRY. SEPTEMBER 1970.
POPE, AJ
GEODETIC RESEARCH AND DEVELOPMENT LAB., ROCKVILLE, MD.
ESSA-TR-C AND GS-39

18P. A CASE IS MADE FOR INCREASED USE OF A METHOD OF REPRESENTING AN ORTHOGONAL MATRIX THAT IS DIFFERENT FROM THE ONE NOW USED IN MOST ANALYTICAL PHOTOGRAMMETRIC SOLUTIONS. THE RELEVANT COMPUTATIONAL FORMULAS ARE GIVEN, ALONG WITH THEIR DERIVATION AND GEOMETRIC INTERPRETATION.

ANALYTICAL PHOTOGRAMMETRY

73W-00-5374

73W 05374. ELECTRICAL ANALOG ANALYSIS OF GROUND WATER DEPLETION IN CENTRAL ARIZONA. 1968.
ANDERSON, TW
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 1860

21P. THE SALT RIVER VALLEY AND THE LOWER SANTA CRUZ RIVER BASIN ARE THE TWO LARGEST AGRICULTURAL AREAS IN ARIZONA. THE EXTENSIVE USE OF GROUND WATER FOR IRRIGATION HAS RESULTED IN THE NEED FOR A THOROUGH APPRAISAL OF THE PRESENT AND FUTURE GROUND WATER RESOURCES. THE DEPLETION PROBLEM IS OF ECONOMIC IMPORTANCE BECAUSE GROUND WATER WILL BECOME MORE EXPENSIVE AS PUMPING LIFTS INCREASE AND WELL YIELDS DECREASE. THE USE OF ELECTRICAL ANALOG MODELING TECHNIQUES HAS MADE IT POSSIBLE TO PREDICT FUTURE GROUND WATER LEVELS UNDER CONDITIONS OF CONTINUED WITHDRAWAL IN EXCESS OF THE RATE OF REPLENISHMENT. THE PREDICTION OF FUTURE WATER TABLE CONDITIONS IS ACCOMPLISHED BY A SIMPLE EXTENSION OF THE PUMPING TRENDS TO DETERMINE THE RESULTANT EFFECT ON THE REGIONAL WATER LEVELS.

GROUND WATER# AQUIFERS# PUMPING

73W-00-5375

73W 05375. ELECTRICAL ANALOG MODEL STUDY OF WATER RESOURCES OF THE COLUMBUS AREA, BARTHOLOMEW COUNTY, INDIANA. 1970.
WATKINS, FA# HEISEL, JE
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 1981

22P. THE COLUMBUS STUDY AREA IS IN PART OF A GLACIAL OUTWASH SAND AND GRAVEL AQUIFER THAT WAS DEPOSITED IN A PREGLACIAL BEDROCK VALLEY. THE STUDY AREA EXTENDS FROM THE NORTH LINE OF BARTHOLOMEW COUNTY TO THE SOUTH COUNTY LINE AND INCLUDES A SMALL PART OF JACKSON COUNTY SOUTH OF SAND CREEK AND EAST OF THE EAST FORK WHITE RIVER. THIS REPORT AREA INCLUDES ABOUT 100 SQUARE MILES OF THE AQUIFER.
AN ELECTRICAL ANALOG MODEL WAS BUILT TO ANALYZE THE AQUIFER SYSTEM AND DETERMINE THE EFFECTS OF DEVELOPMENT. ANALYSIS OF THE MODEL INDICATES THAT THERE IS MORE THAN ENOUGH WATER TO MEET THE ESTIMATED NEEDS OF THE CITY OF COLUMBUS WITHOUT SERIOUSLY DEPLETING THE AQUIFER.

WATER RESOURCES# AQUIFERS# HYDROLOGY

73W-00-5376

73W 05376. METHODS AND APPLICATIONS OF ELECTRICAL SIMULATION IN GROUND WATER STUDIES IN THE LOWER ARKANSAS AND VERDIGRIS RIVER VALLEYS, ARKANSAS AND OKLAHOMA. 1970.
BEDINGER, MS# REED, JE# WELLS, CJ# SWAFFORD, BF
U.S. GEOLOGICAL SURVEY, WASHINGTON, D.C.
PAPER 1971

71P. IN 1957 THE U.S. GEOLOGICAL SURVEY AND U.S. ARMY CORPS OF ENGINEERS ENTERED INTO A COOPERATIVE AGREEMENT FOR A COMPREHENSIVE GROUND WATER STUDY OF THE LOWER ARKANSAS AND VERDIGRIS RIVER VALLEYS. AT THE REQUEST OF THE CORPS OF ENGINEERS, THE GEOLOGICAL SURVEY AGREED TO PROVIDE (1) BASIC GROUND WATER DATA BEFORE, DURING, AND AFTER CONSTRUCTION OF THE MULTIPLE PURPOSE PLAN AND (2) INTERPRETATION AND PROJECTIONS OF POSTCONSTRUCTION GROUND WATER CONDITIONS. THE DATA COLLECTED WERE USED BY THE CORPS OF ENGINEERS IN PRELIMINARY FOUNDATION AND EXCAVATION ESTIMATES AND BY THE GEOLOGICAL SURVEY AS THE BASIS FOR DEFINING THE HYDROLOGIC PROPERTIES OF, AND THE GROUND WATER CONDITIONS IN, THE AQUIFER. ANALYSIS AND PROJECTIONS OF GROUND WATER CONDITIONS WERE MADE BY USE OF ELECTRICAL ANALOG MODELS. THESE MODELS USE THE ANALOGY BETWEEN THE FLOW OF ELECTRICITY IN A RESISTANCE CAPACITANCE CIRCUIT AND THE FLOW OF A LIQUID IN A POROUS AND PERMEABLE MEDIUM.

GROUND WATER# AQUIFERS# SIMULATION

73W-00-5377

73W 05377. MUSKINGUM FLOOD ROUTING OF UPLAND STREAMFLOW.
JOURNAL OF HYDROLOGY. VOL. 4, 1966. P185-200.
OVERTON, DE
AGRICULTURE DEPT., BELTSVILLE, MD.

THE RESULTS OF FLOOD ROUTING TRIALS ON A SMALL ARS EXPERIMENTAL WATERSHED USING THE MUSKINGUM FLOOD ROUTING SYSTEM SHOWED THAT THE ROUTING COEFFICIENTS K AND X VARY FOR EACH STORM. BY APPROXIMATING THE OBSERVED INFLOW HYDROGRAPHS BY A SIMPLE TRIANGULAR SHAPE, DIRECT SOLUTION FOR THE ROUTING COEFFICIENTS WAS POSSIBLE.

FLOOD ROUTING# STREAM FLOW# WATERSHEDS

73W-00-5378

ARS-41-116. A RUNOFF HYDROGRAPH EQUATION. FEBRUARY 1966.
DECOURSEY, DG
AGRICULTURE DEPT., CHICKASHA, OKLA.
ARS-41-116

23P. THIS PAPER PRESENTS AN EQUATION THAT DEFINES THE SURFACE RUNOFF HYDROGRAPH AND DEVELOPS A METHOD FOR DETERMINING THE CONSTANTS IN THE EQUATION. IT WAS DERIVED IN STUDIES OF SIX WATERSHEDS IN THE OKLAHOMA PORTION OF THE WASHITA RIVER BASIN. IT IS BELIEVED THAT THE EQUATION FILLS THE NEED FOR A GENERAL FUNCTIONAL RELATION THAT CAN BE USED IN THE ELECTRONIC COMPUTER ANALYSIS OF STREAMFLOW PROBLEMS.

SURFACE WATER RUNOFF# STREAM FLOW# HYDROGRAPHY

73W-00-5379

73W 05379. JOURNAL OF THE HYDRAULICS DIVISION. PROCEEDINGS OF THE ASCE. VOL. 97. SEPTEMBER 1971. P1349-1523.
AMERICAN SOCIETY OF CIVIL ENGINEERS.

CONTENTS INCLUDE: HOURLY RAINFALL SYNTHESIS FOR A NETWORK; MECHANICS OF SHEET FLOW UNDER SIMULATED RAINFALL; AND DE SAINT-VENANT EQUATIONS EXPERIMENTALLY VERIFIED.

RAINFALL# FLOOD ROUTING# HYDROLOGY# HYDRAULICS

73W-00-5380

73W 05380. A RAINFALL RUNOFF SIMULATION MODEL FOR ESTIMATION OF FLOOD PEAKS FOR SMALL DRAINAGE BASINS. 1970.
DAWDY, DR# LICHTY, RW# BERGMANN, JM
GEOLOGICAL SURVEY, WASHINGTON, D.C.

90P. A PARAMETRIC RAINFALL RUNOFF SIMULATION MODEL IS USED WITH POINT RAINFALL AND DAILY POTENTIAL EVAPOTRANSPIRATION DATA TO PREDICT FLOOD VOLUME AND PEAK RATES OF RUNOFF FOR SMALL DRAINAGE AREAS. THE MODEL IS BASED ON BULK PARAMETER APPROXIMATIONS TO THE PHYSICAL LAWS GOVERNING INFILTRATION, SOIL MOISTURE ACCRETION AND DEPLETION, AND SURFACE STREAMFLOW. AN OBJECTIVE FITTING METHOD IS USED FOR DETERMINING OPTIMAL BEST FIT SETS OF PARAMETER VALUES FOR THE DATA AVAILABLE FOR USE IN PREDICTING FLOOD PEAKS FOR THREE CASE STUDIES.

RAINFALL# SURFACE WATER RUNOFF# SIMULATION
DIGITAL COMPUTERS# HYDROLOGY

73W-00-5390

RP-7. OPTIMIZATION BY THE PATTERN SEARCH METHOD.
JANUARY 1970.
GREEN, RF
TVA, KNOXVILLE, TENN.
RP-7

73P. AN INFINITE NUMBER OF MATHEMATICAL MODELS CAN BE CREATED TO DESCRIBE NATURALLY OCCURRING PHYSICAL SYSTEMS. IN ADDITION THERE IS A SMALLER, BUT LARGE, NUMBER OF CRITERIA WHICH CAN BE USED TO MEASURE THE GOODNESS OF FIT OF A MODEL TO A PHYSICAL PROCESS. TOGETHER, A SELECTED CRITERION AND A MATHEMATICAL MODEL DEFINE AN OBJECTIVE FUNCTION TO BE OPTIMIZED. THEN THERE ARE SEVERAL DIFFERENT FITTING OR OPTIMIZING TECHNIQUES WHICH CAN BE USED TO OPTIMIZE (MINIMIZE OR MAXIMIZE) THE OBJECTIVE FUNCTION AND PROVIDE A QUANTIFICATION OF THE PARAMETERS OF THE OBJECTIVE FUNCTION.

OPTIMIZATION# MATHEMATICAL MODELS
COMPUTER PROGRAMS

73W-00-5391

TR-3. A QUANTITATIVE GEOMORPHIC STUDY OF DRAINAGE BASIN CHARACTERISTICS IN THE CLINCH MOUNTAIN AREA - VIRGINIA AND TENNESSEE. 1953.
MILLER, VC
COLUMBIA UNIV., NEW YORK, N.Y.
TR-3

79P. QUANTITATIVE STUDY OF STREAM LENGTH, BASIN AREA, DRAINAGE DENSITY, BASIN CIRCULARITY, VALLEY SIDE SLOPES, AND HYPSOMETRIC CURVES WAS MADE OF TWO KINDS OF TOPOGRAPHY IN THE CLINCH MOUNTAIN AREA OF VIRGINIA AND TENNESSEE. SAMPLES OF THE FORM ELEMENTS WERE TAKEN FROM LARGE SCALE TOPOGRAPHIC MAPS AND AIR PHOTOGRAPHS, CHECKED BY FIELD OBSERVATIONS. SIGNIFICANT DIFFERENCES IN SAMPLE MEANS WERE DETERMINED THROUGH ANALYSIS OF VARIANCE.

WATERSHEDS# STREAMS# GEOMORPHOLOGY

73W-00-5392

73W 05392. ANNUAL REPORT OF THE TENNESSEE VALLEY AUTHORITY - 1970. DECEMBER 1970.
TVA, MUSCLE SHOALS, ALA.

73P. CONTENTS: TVA 1970 - HIGHLIGHTS; TECHNOLOGY - TOOLS TO BUILD A BETTER LIFE; MANAGING THE MULTIPLE USES OF WATER AND LAND; POWER FOR A GROWING REGION; FORESTRY, FISHERIES, AND WILDLIFE; FERTILIZER AND AGRICULTURAL ADVANCES; AND TRIBUTARY AREA DEVELOPMENT.

LAND DEVELOPMENT# ELECTRIC POWER# FISHERIES
FORESTRY# AGRICULTURE

73W-00-5395

73W 05395. TVA - 1969. 1970
TVA, KNOXVILLE, TENN.

92P. CONTENTS: TVA 1969 - HIGHLIGHTS; ECONOMIC GROWTH AND ENVIRONMENTAL QUALITY - SEEKING THE GOLDEN MEAN; MANAGING THE MULTIPLE USES OF WATER AND LAND; ELECTRIC POWER PROGRESS; TRIBUTARY AREA DEVELOPMENT; FORESTRY PROGRESS; FERTILIZER AND AGRICULTURE PROGRESS.

LAND DEVELOPMENT# ELECTRIC POWER# FORESTRY
AGRICULTURE# FERTILIZERS

73W-00-5397

73W 05397. THE ROLE OF WEATHER FORECASTS IN TVA RESERVOIR OPERATIONS. FEBRUARY 1969.
COOPER, AJ
TVA, KNOXVILLE, TENN.

37P. THE EXTENT OF SUCCESS IN THE OPERATION OF THE COMPLEX TVA RESERVOIR SYSTEM TO ACHIEVE MULTIPLE PURPOSES IS DEPENDENT TO A CONSIDERABLE DEGREE UPON THE AVAILABILITY AND RELIABILITY OF OBSERVED AND PREDICTED METEOROLOGIC AND HYDROLOGIC INFORMATION. QUANTITATIVE WEATHER FORECASTS ARE BECOMING INCREASINGLY IMPORTANT IN THE DAILY OPERATIONS OF THE TENNESSEE VALLEY AUTHORITY RESERVOIRS TO REALIZE THE SYSTEM OBJECTIVES. THE SCOPE OF WEATHER FORECASTS WHICH TVA RECEIVES FROM ESSA WEATHER BUREAU, HOW THEY ARE USED, AND THEIR IMPORTANCE AND EFFECT IN SCHEDULING THE OPERATIONS OF THE WATER CONTROL AND POWER SYSTEMS IS THE SUBJECT OF THIS PAPER.

WEATHER FORECASTING# RESERVOIRS

73W-00-5404

73W 05404. UNSTEADY FLOW SIMULATION IN RIVERS AND RESERVOIRS.
JOURNAL OF THE HYDRAULICS DIVISION. SEPTEMBER 1969.
P1559-1576.
GARRISON, JM# GRANJU, JP# PRICE, JT
TVA, KNOXVILLE, TENN.

MOST MATHEMATICAL MODELING OF UNSTEADY FLOW PHENOMENA HAS BEEN LIMITED TO PRISMATIC CHANNELS AND SOMEWHAT IDEALIZED CONDITIONS. THE TENNESSEE VALLEY AUTHORITY (TVA) USING THE NUMERICAL METHODS DEVELOPED BY STOKER HAS SUCCESSFULLY APPLIED THEM TO A NUMBER OF COMPLEX UNSTEADY FLOW CONDITIONS WHICH HAVE OCCURRED OR ARE EXPECTED TO OCCUR IN SOME OF THE AUTHORITY'S RESERVOIRS AND NATURAL RIVER CHANNELS.
THE RESULTS SHOW THE ADVANTAGES AND APPLICABILITY OF THE DIGITAL COMPUTER OVER QUASISTEADY FLOW METHODS OF HANDLING UNSTEADY FLOW PROBLEMS. ALSO POINTED OUT ARE AREAS IN THE MATHEMATICAL MODEL IN WHICH DIFFICULTIES HAVE BEEN ENCOUNTERED ALONG WITH THE METHODS REQUIRED TO OVERCOME THEM. THESE ARE DESCRIBED TO ASSIST OTHERS IN USING THE MODEL.

MATHEMATICAL MODELS# DIGITAL COMPUTERS
UNSTEADY FLOW# SIMULATION

73W-00-5417

73W 05417. SENSOR DEFINITION STUDY IN SUPPORT OF UNIFIED SPACE APPLICATIONS MISSION (USAM). FEBRUARY 1968.
IBM, BETHESDA, FSD
NAS5-10436

250P. THIS REPORT PRESENTS THE RESULTS OF A SENSOR DEFINITION STUDY IN SUPPORT OF THE UNIFIED SPACE APPLICATIONS MISSION CONCEPT. THE STUDY DETERMINED THE IMPORTANT CHARACTERISTICS OF REQUIRED SENSORS AND IDENTIFIED COMMONALITY ASPECTS OF SENSORS AND ORBITS TO PERFORM USEFUL EARTH ORIENTED TASKS IN THE 1970 AND 1975 TIME FRAMES. IT ALSO IDENTIFIED EXPERIMENT (TASK) PARAMETERS AGAINST WHICH SENSOR PERFORMANCE WAS EVALUATED.

DETECTORS# REMOTE SENSING# ARTIFICIAL SATELLITES

73W-00-5419

73W 05419. EARTH ORBITAL EXPERIMENT PROGRAM.
IBM, FSD

99P. UNDERLYING THE RECOMMENDED SYNTHESIS APPROACH IS THE RECOGNITION THAT ORL, OF WHICH AAP IS THE INITIAL EMBODIMENT, REPRESENTS NOT JUST A PLATFORM FOR PERFORMING UNRELATED EXPERIMENTS BUT A WORKSHOP FOR CONTRIBUTING TO SOLUTION OF NATIONAL AND INTERNATIONAL PROBLEMS AND FOR ILLUMINATING CRUCIAL SCIENTIFIC QUESTIONS. THIRTEEN FIELDS OF ACTIVITY, CALLED SCIENTIFIC/TECHNICAL (S/T) AREAS, WERE IDENTIFIED AS POTENTIALLY BENEFITING FROM ORL.

EARTH ORBITS# SPACE EXPLORATION

73W-00-5424

73W 05424. THE PRESIDENTS 1971 ENVIRONMENTAL PROGRAM. MARCH 1971.
TRAIN, RE# CAHN, R# MACDONALD, GJ
COUNCIL ON ENVIRONMENTAL QUALITY

305P. THIS REPORT CONTAINS THE PRESIDENTS MESSAGE ON THE ENVIRONMENT AND SPECIFIC INFORMATION ON THE PRESIDENTS 1971 PROPOSALS. INCLUDED ARE THE BILLS, THE LETTERS OF TRANSMITTAL TO THE CONGRESS, AND ANALYSES OF THE PROPOSED LEGISLATION.

ENVIRONMENTS

73W-00-5430

N69-34930. POTENTIAL BENEFITS TO BE DERIVED FROM APPLICATIONS OF REMOTE SENSING OF AGRICULTURAL, FOREST, AND RANGE RESOURCES. DECEMBER 1967.
BELCHER, DJ# HARDY, EE# SHELTON, RL# SHEPIS, EL
CORNELL UNIV., ITHACA, N.Y.
N69-34930# NASA-CR-103946

150P. THIS REPORT EXPLORES THE USES AND ASSOCIATED VALUES OF THE INFORMATION WHICH CAN NOW OR IN THE FUTURE BE PROVIDED BY REMOTE SENSING FROM CONVENTIONAL AND HIGH FLYING AIRCRAFT AND FROM SATELLITES. SUPPORTING MATERIAL, COMPRISING TECHNICAL AND ECONOMIC ANALYSES OF THESE USES (OR APPLICATIONS), STEMMED FROM A DETAILED AND CRITICAL EVALUATION OF REMOTE SENSORS AND OF THE AGRICULTURAL FOREST, AND RANGE RESOURCES TO WHICH THEY ARE APPLIED. THE OBJECTIVE OF THE REPORT IS TO INDICATE THE MAGNITUDE OF THE POTENTIAL VALUES THAT MAY BE DERIVED FROM REMOTE SENSING OF THESE RESOURCES.

REMOTE SENSING# AIRCRAFT# ARTIFICIAL SATELLITES

73W-00-5431

N70-25632. REVIEW OF NEW GEOGRAPHIC METHODS AND TECHNIQUES. QUESTIONNAIRE SURVEY. WATER RESOURCES PLANNING AND MANAGEMENT. RECENT TRENDS IN REMOTE SENSING TECHNOLOGY. OCTOBER 1969.
TATA, RJ# PALMER, CE# WITMER, RE
FLORIDA ATLANTIC UNIV., BOCA RATON
N70-25632# AD700176

97P. IN DOING WORK FOR A RESEARCH PROJECT ON NEW GEOGRAPHIC METHODS AND TECHNIQUES, THE THREE REPORTS AND BIBLIOGRAPHIES INCLUDED IN THIS STUDY WERE DEVELOPED. BECAUSE THE REPORTS ARE OF INTEREST, BUT NOT DIRECTLY RELATED, TO THE CENTRAL GOAL OF THE METHODOLOGICAL TREATISE, THEY ARE PRESENTED FOR RESEARCHERS CONCERNED. THE FIRST REPORT SUMMARIZES THE RESULTS OF A QUESTIONNAIRE SURVEY OF GEOGRAPHERS WHO ARE ACTIVE IN RESEARCHING METHODOLOGICAL TOPICS; THE SECOND REPORT DEALS WITH THE GEOGRAPHERS ROLE IN STUDIES OF WATER RESOURCE PLANNING AND MANAGEMENT; AND THE FINAL STUDY COMPRISES REPORT AND BIBLIOGRAPHY ON NEW SYSTEMS OF REMOTE SENSING TECHNIQUES.

REMOTE SENSING# GEOGRAPHY# WATER RESOURCES

73W-00-5432

N70-18106. OCEANOGRAPHY USING REMOTE SENSING. JANUARY 1969.
CAPURRO, LR
TEXAS A AND M UNIV., COLLEGE STATION
N70-18106# AD682939# NASA-CR-107898

109P. AIRBORNE TESTS OF MULTISPECTRAL REMOTE SENSORS WERE CONDUCTED ON EIGHT OCCASIONS DURING JULY 1966 TO SEPTEMBER 1968 OVER THE MISSISSIPPI DELTA AREA AND EASTERN GULF OF MEXICO TO DETERMINE THEIR USEFULNESS IN SURVEYING RIVER, COASTAL AND DEEP SEA PHENOMENA. FOUR OF THESE TESTS WERE SUPPORTED CONCURRENTLY BY OCEANOGRAPHIC RESEARCH VESSELS, PASSIVE REMOTE SENSORS, INCLUDING METRIC CAMERAS, INFRARED IMAGERS AND MICROWAVE RADIOMETERS. STUDIES INTO THE RELATIONSHIP BETWEEN LOW CLOUD DEVELOPMENT AND HORIZONTAL ANOMALIES IN THE SEA SURFACE TEMPERATURE FIELD AND STUDIES INTO BASIC MICROWAVE RESEARCH HAVE BEEN CONDUCTED.

OCEANOGRAPHY# REMOTE SENSING

73W-00-5437

N71-15653. REMOTE SENSING PROJECT. PHASE C: AGRICULTURE. SEPTEMBER 1970.
COELHO, AG# MCNEILL, HW
COMISSAO NACIONAL DE ATIVIDADES ESPACIAIS, SAO JOSE DOS CAMPOS, BRAZIL
N71-15653# TR-LAFE-132

102P. BRAZILIAN AGRICULTURAL REMOTE SENSING RESEARCH PROJECTS ARE DESCRIBED. SUBJECTS DISCUSSED ARE: (1) FIELD MEASUREMENTS, (2) COFFEE SPACING, (3) SOILS, (4) SOIL NUTRIENT STATUS, (5) LAND USE CAPABILITY, (6) YIELD PREDICTION, (7) PRIMARY YIELD EVALUATION, (8) TOLERANCE THEORY, (9) SYSTEM FOR CROP BOUNDARY AND NATURAL VEGETATION, AND (10) BOUNDARY RECOGNITION.

REMOTE SENSING# AGRICULTURE

73W-00-5459

73W 05459. PRINCIPLES OF OPTICAL DATA PROCESSING FOR ENGINEERS. AUGUST 1966.
SHULMAN, AP
GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.

120P. THIS DOCUMENT IS PRIMARILY WRITTEN FOR ENGINEERS AS A SELF TEACHING TEXT ON OPTICAL DATA PROCESSING. BASIC FUNDAMENTALS NECESSARY FOR UNDERSTANDING THE SUBJECT ARE REVIEWED AND EXPANDED UPON TO GIVE A CLEAR UNDERSTANDING AND WORKING KNOWLEDGE OF THE ENTIRE AREA, INCLUDING: OPTICAL SPECTRUM ANALYSIS, OPTICAL CORRELATION, PHOTOGRAPHIC FILM CHARACTERISTICS, AND HOLOGRAPHY. IN ADDITION, THIS DOCUMENT INTRODUCES THE USE OF MATHEMATICS TO DESCRIBE THE VARIOUS OPTICAL OPERATIONS, THUS FORMING A BACKGROUND FOR UNDERSTANDING MORE ADVANCED WORKS IN THE FIELD.

OPTICAL STORAGE# DATA PROCESSING# HOLOGRAPHY

73W-00-5460

TR-39. DIGITAL SIMULATION IN HYDROLOGY: STANFORD WATERSHED MODEL 4. JULY 1966.
CRAWFORD, NH# LINSLEY, RK
STANFORD UNIV., CALIF.
TR-39

210P. TABLE OF CONTENTS: SIMULATION METHODS AND HYDROLOGIC MODELS; THE HYDROLOGIC CYCLE; A GENERAL SIMULATION MODEL; OPERATION OF THE MODEL; SIMULATION RESULTS; AND APPLICATIONS OF SIMULATION.

HYDROLOGY# DIGITAL SIMULATION# WATERSHEDS

73W-00-5503

MSC-02576-VOL. 1. EARTH RESOURCES RESEARCH DATA FACILITY INDEX. VOLUME 1 - DOCUMENTARY DATA. JANUARY 1971.
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
MSC-02576-VOL. 1

255P. THIS DOCUMENT IS PRESENTED IN TWO VOLUMES AND IS THE CUMULATIVE ISSUE OF THE EARTH RESOURCES RESEARCH DATA FACILITY (ERRDF) INDEX. VOLUME 1 LISTS ALL EARTH RESOURCES PROGRAM DOCUMENTARY INFORMATION THAT IS AVAILABLE AT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION'S MANNED SPACECRAFT CENTER. THE INFORMATION CATALOGED IN THIS VOLUME IS DIVIDED INTO TWO MAJOR DATA CATAGORIES AS FOLLOWS: PART 1 - TECHNICAL DOCUMENTS AND MAPS, AND PART 2 - SATELLITE DATA.

RESOURCES# EARTH /PLANET/# DOCUMENTS

73W-00-5504

MSC-02576-VOL. 2. EARTH RESOURCES RESEARCH DATA FACILITY INDEX. VOLUME 2 - SENSOR DATA. JANUARY 1971.
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
MSC-02576-VOL. 2

100P. THIS DOCUMENT IS PRESENTED IN TWO VOLUMES AND IS THE CUMULATIVE ISSUE OF THE EARTH RESOURCES RESEARCH DATA FACILITY (ERRDF) INDEX. INCLUDED IN VOLUME 2 OF THE INDEX ARE SENSOR DATA COLLECTED DURING FLIGHTS OVER TEST SITES AND FROM MISSIONS FLOWN BY SUBCONTRACTORS SUPPORTING THE EARTH RESOURCES SURVEY PROGRAM. THE INFORMATION CATALOGED IN THIS VOLUME IS DIVIDED INTO THREE MAJOR DATA CATAGORIES AS FOLLOWS: PART 3 - FUNCTIONAL AND CHECK OUT DATA, PART 4 - IMAGERY DATA, AND PART 5 - ELECTRONIC DATA.

RESOURCES# EARTH /PLANET/# DETECTION

73W-00-5506

73W 05506. PROCEEDINGS OF IES 1969 ANNUAL TECHNICAL MEETING. APRIL 1969.
INSTITUTE OF ENVIRONMENTAL SCIENCES

645P. SOME OF THE SPECIFIC ENVIRONMENTS EXPLORED DURING THIS MEETING WERE POLLUTION, TRANSPORTATION, NOISE, AND BIOENGINEERING.

POLLUTION# NOISE /SOUND/# TRANSPORTATION
BIOENGINEERING

73W-00-5507

NASA-CR-1380. STUDY OF AIR POLLUTANT DETECTION BY REMOTE SENSORS. 1968.
LUDWIG, CB# BARTLE, R# GRIGGS, M
GENERAL DYNAMICS CORP., SAN DIEGO, CALIF.
NASA-CR-1380# GDC-DBE68-011

150P. IN THIS STUDY THE FEASIBILITY OF DETECTING THE MAJOR AIR POLLUTANTS BY EARTH ORIENTED, SATELLITE BORNE SENSORS IS INVESTIGATED. IN THE FIRST PART OF THIS REPORT, A DISCUSSION OF THE POLLUTANT SPECIES, THEIR OCCURRENCE, FORMATION, CHEMISTRY, CONCENTRATION LEVELS, AND DISTRIBUTION PROFILES THROUGH THE ATMOSPHERE IS GIVEN. THE PROBLEMS OF DETECTION IN THE UV AND VISIBLE REGIONS, IN RELATION TO AEROSOL AND MOLECULAR SCATTERING, ARE DISCUSSED. CALCULATIONS OF SIGNAL CHANGES EXPECTED FOR AN IDEAL RAYLEIGH ATMOSPHERE ARE PRESENTED. SOME CONSIDERATIONS OF AEROSOL (PARTICULATE) POLLUTION DETECTION ARE DISCUSSED. IN THE SECOND PART, A PERFORMANCE EVALUATION OF EIGHT DIFFERENT SPECTROSCOPIC INSTRUMENTS FOR THE REMOTE DETECTION OF POLLUTANTS IS MADE.

AIR POLLUTION# DETECTION# REMOTE SENSING
SPACEBORNE DETECTORS# SPECTROSCOPY

73W-00-5508

73W 05508. PROCEEDINGS OF IES 1968 ANNUAL TECHNICAL MEETING.
MAY 1968.
INSTITUTE OF ENVIRONMENTAL SCIENCES

573P. THE DEVELOPMENT OF THE TECHNOLOGY BASIC TO THE ENDEAVOR OF THE IES HAS IN THE PAST BEEN INSPIRED PRIMARILY BY MILITARY AND AEROSPACE REQUIREMENTS. IT IS TIME FOR THE ENVIRONMENTAL ENGINEER AND SCIENTIST TO CONSIDER NEW CIVILIAN APPLICATIONS FOR ENVIRONMENTAL TECHNOLOGY IN OUR EXPANDING ECONOMY.
THIS TECHNICAL PROGRAM OF THE IES INCLUDES NOT ONLY RECENT DEVELOPMENTS ASSOCIATED WITH THE MILITARY AND AEROSPACE FIELD BUT ALSO APPLICATIONS OF ENVIRONMENTAL SCIENCE TO HIGH-SPEED TRANSPORTATION, POLLUTION CONTROL AND OTHER AREAS OF EFFORT AIMED AT IMPROVING MANS LOT.

TRANSPORTATION# POLLUTION

73W-00-5509

N70-14072 THRU N70-14104. REMOTE SENSING OF THE ENVIRONMENT.
AUGUST 1968.
CALIFORNIA UNIV., LOS ANGELES
N70-14072 THRU N70-14104# REPT-807.4

250P. LECTURES GIVEN DURING A SHORT STUDY COURSE IN REMOTE SENSING OF ENVIRONMENT ARE PRESENTED, WITH EMPHASIS ON FUNDAMENTAL CONCEPTS, TECHNIQUES AND EQUIPMENT, AND POTENTIAL APPLICATIONS. IMAGING TECHNIQUES; SPECIFIC TYPES OF SENSORS, INCLUDING SIDE LOOKING RADAR SYSTEMS AND MULTISPECTRAL SCANNERS; GROUND TRUTH REQUIREMENTS; ENVIRONMENTAL FACTORS AFFECTING SYSTEM PERFORMANCE; AND DATA PROCESSING METHODS ARE TREATED IN DETAIL. FIELDS OF APPLICATION DISCUSSED IN THE VARIOUS LECTURES ARE METEOROLOGY, OCEANOGRAPHY, EARTH RESOURCE MANAGEMENT AND DISCOVERY, GEOLOGY, AND GEOGRAPHY.

REMOTE SENSING# DETECTORS# UTILIZATION

73W-00-5510

N70-42766. EARTH SURVEY BIBLIOGRAPHY: A KWIC INDEX OF REMOTE SENSING INFORMATION. SEPTEMBER 1970.
THOMPSON, WI
TRANSPORTATION SYSTEMS CENTER, CAMBRIDGE, MASS.
N70-42766

269P. A BIBLIOGRAPHY OF CITATIONS PERTAINING TO THE EARTH RESOURCES PROGRAM IS PRESENTED. THE SCOPE RANGES FROM DETAILED DISCUSSIONS ON THE POLITICS OF EARTH SURVEY OPERATIONS TO SELECTION OF FILM USED FOR AERIAL SURVEYS. THE BIBLIOGRAPHY IS INTENDED AS A SOURCE DOCUMENT LEADING TO SPECIFIC INFORMATION AND SOURCES OF ADDITIONAL INFORMATION.

REMOTE SENSING# RESOURCES

73W-00-5511

N71-16166 THRU N71-16186. EARTH RESOURCES AIRCRAFT PROGRAM STATUS REVIEW. VOLUME III: HYDROLOGY, OCEANOGRAPHY, AND SENSOR STUDIES. SEPTEMBER 1968.
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N71-16166 THRU N71-16186# NASA-TMX-62566

530P. ON SEPTEMBER 16, 17, AND 18, 1968 A REVIEW OF VARIOUS ASPECTS OF THE EARTH RESOURCES PROGRAM WAS HELD AT THE MANNED SPACECRAFT CENTER, HOUSTON, TEXAS. A REVIEW OF THE VARIOUS ASPECTS OF THE EARTH RESOURCES PROGRAM, DIVIDED INTO GEOLOGY, GEOGRAPHY, HYDROLOGY, AGRICULTURE AND FORESTRY, AND OCEANOGRAPHY, IS PRESENTED. INFORMATION IS PRESENTED ON THE CURRENT STATUS OF CONTINUING PROGRAMS, WITH EMPHASIS ON REMOTE SENSOR APPLICATIONS IN HYDROLOGY AND OCEANOGRAPHY.

HYDROLOGY# OCEANOGRAPHY# DETECTION
REMOTE SENSING

73W-00-5512

N71-11151 THRU N71-11170. SECOND ANNUAL EARTH RESOURCES AIRCRAFT PROGRAM STATUS REVIEW. VOLUME III: HYDROLOGY AND OCEANOGRAPHY. SEPTEMBER 1969.
MANNED SPACECRAFT CENTER, HOUSTON, TEX.
N71-11151 THRU N71-11170# NASA-TMX-66481

372P. ON SEPTEMBER 16, 17, AND 18, 1969 A REVIEW OF VARIOUS ASPECTS OF THE EARTH RESOURCES PROGRAM WAS HELD AT THE MANNED SPACECRAFT CENTER, HOUSTON, TEXAS. CONFERENCE PAPERS ARE PRESENTED ON HYDROLOGICAL AND OCEANOGRAPHIC STUDIES, AND THE USE OF AERIAL AND SPACEBORNE PHOTOGRAPHY, INFRARED IMAGERY, RADAR DETECTION, AND REMOTE SENSING IN THE STUDIES.

HYDROLOGY# OCEANOGRAPHY# REMOTE SENSING

73W-00-5513

NASA-SP-7036. REMOTE SENSING OF EARTH RESOURCES. A LITERATURE SURVEY WITH INDEXES. 1970.
NASA, WASHINGTON, D.C.
NASA-SP-7036

1221P. THIS SURVEY INCLUDES DOCUMENTS RELATED TO THE IDENTIFICATION AND EVALUATION BY MEANS OF SENSORS IN SPACECRAFT AND AIRCRAFT OF VEGETATION, MINERALS, AND OTHER NATURAL RESOURCES, AND THE TECHNIQUES AND POTENTIALITIES OF SURVEYING. IT ENCOMPASSES STUDIES OF SUCH NATURAL PHENOMENA AS CITIES, TRANSPORTATION NETWORKS, AND IRRIGATION SYSTEMS.

REMOTE SENSING# DETECTORS# RESOURCES
SPACEBORNE DETECTORS# AIRBORNE DETECTORS

73W-00-5525

73W 05525. AN INTRODUCTION TO REGRESSION AND CORRELATION. MARCH 1966.
SMILLIE, KW
ALBERTA UNIV., EDMONTON, CANADA

158P. THIS BOOK WILL BE OF ASSISTANCE TO THE PERSON WHO IS INTERESTED IN A NONMATHEMATICAL ACCOUNT OF REGRESSION ANALYSIS AND WHO IS PREPARED TO LEAVE THE COMPUTATIONAL ASPECTS TO THE PROGRAMMER AND THE COMPUTER.

REGRESSION ANALYSIS# CORRELATION# DIGITAL COMPUTERS

73W-00-5600

73W 05600. AIAA EARTH RESOURCES OBSERVATIONS AND INFORMATION SYSTEMS MEETING. ANNAPOLIS, MD. MARCH 1970. COLLECTION OF TECHNICAL PAPERS.
AMERICAN INST. OF AERONAUTICS AND ASTRONAUTICS

102P. CONTENTS INCLUDE: DATA ANALYSIS AND REMOTELY SENSED DATA; A SURVEY OF SENSORS FOR EARTH RESOURCES SENSING; FUTURE APPLICATIONS OF EARTH RESOURCE SURVEYS FROM SPACE; RESOURCE POLICY, MANAGEMENT, AND REMOTE SENSING; REMOTE SENSORS -- A NEW DATA SOURCE FOR AGRICULTURAL STATISTICS.

REMOTE SENSING# INFORMATION SYSTEMS

73W-00-5601

73W 05601. HYDRODYNAMICS OF MATHEMATICALLY SIMULATED SURFACE RUNOFF. AUGUST 1968.
CHEN, CL# CHOW, VT
ILLINOIS UNIV., URBANA

132P. A MACROSCOPIC HYDRODYNAMIC APPROACH TO ANALYZE THE SURFACE FLOW ON WATERSHEDS IS PRESENTED AND DISCUSSED IN THIS REPORT. IN THIS APPROACH, A SET OF SPATIALLY VARIED UNSTEADY FLOW EQUATIONS, THAT INCLUDE TERMS FOR LATERAL MASS FLUX, LATERAL MOMENTUM FLUX, OVERPRESSURE HEAD DUE TO RAINDROP IMPACT, AND BOUNDARY SHEAR, ARE DERIVED FROM THE EQUATION OF CONTINUITY AND THE NAVIER STOKES EQUATIONS FOR THE THREE DIMENSIONAL FLOW OF VISCOUS INCOMPRESSIBLE FLUID IN COOPERATION WITH THE KINEMATIC AND DYNAMIC BOUNDARY CONDITIONS ON THE WATER AND GROUND SURFACES OF A WATERSHED. SEVERAL TYPES OF EXTERNAL AND INTERNAL BOUNDARY CONDITIONS FOR WATERSHED SURFACE FLOW ARE PRESENTED AND DISCUSSED IN THIS REPORT.

HYDRODYNAMICS# MATHEMATICAL MODELS# WATERSHEDS

73W-00-5602

73W 05602. COMPUTER SOLUTION OF A HYDRODYNAMIC WATERSHED MODEL (IHW MODEL 2). MARCH 1971.
KARELIOTIS, SJ# CHOW, VT
ILLINOIS UNIV., URBANA

128P. THIS REPORT DESCRIBES THE GENERAL COMPUTER SOLUTION OF A HYDRODYNAMIC MODEL OF WATERSHED FLOW, THE SO CALLED ILLINOIS HYDRODYNAMIC WATERSHED MODEL 2 (IHW MODEL 2). THIS MODEL IS FORMULATED MATHEMATICALLY ON THE BASIS OF THE CONTINUITY AND MOMENTUM PRINCIPLES, CONSISTING OF THE USE OF NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS AND EMPLOYING THE CONCEPTS OF OVERPRESSURE HEAD DUE TO RAINDROP IMPACT AND THE ADJUSTMENT OF THE DARCY WEISBACH FLOW RESISTANCE. FOR THE COMPUTATION OF THE HYDRODYNAMIC MODEL, A SET OF PROCEDURES IS DEVELOPED FOR THE SELECTION OF THE INITIAL CONDITIONS AND FOR THE NUMERICAL SOLUTION AT BOUNDARY POINTS, INCLUDING HYDRAULIC JUMPS IN THE FLOW. RESULTS OF THIS STUDY INDICATE THAT THE PROPOSED IHW MODEL 2 IS IN GENERAL FEASIBLE FOR THE SIMULATION OF THE HYDRODYNAMIC BEHAVIOR OF THE WATERSHED FLOW.

HYDRODYNAMICS# WATERSHEDS# MATHEMATICAL MODELS

73W-00-5603

RR-36. AN EVALUATION OF RELATIONSHIPS BETWEEN STREAM FLOW PATTERNS AND WATERSHED CHARACTERISTICS THROUGH THE USE OF OPSET. 1970.
JAMES, LD
KENTUCKY UNIV., LEXINGTON
RR-36

117P. SELECTION AMONG ALTERNATIVE FLOOD CONTROL MEASURES WOULD BE BETTER INFORMED IF BETTER INFORMATION COULD BE OBTAINED ON THE MARGINAL CHANGE IN FLOOD HAZARD ASSOCIATED WITH LAND USE AND OTHER CHANGES IN THE TRIBUTARY WATERSHED. HYDROLOGIC MODELING IS THE MOST PROMISING APPROACH TO ANSWERING THIS QUESTION; HOWEVER, THE USE OF EXISTING MODELS IS HAMPERED BY THE ABSENCE OF INFORMATION CORRELATING MODEL PARAMETERS WITH PHYSICAL CHARACTERISTICS OF THE WATERSHED. TO DEAL WITH THIS SITUATION, A METHOD WAS DEVELOPED FOR ESTIMATING THE PARAMETER VALUES FOR THE STANFORD WATERSHED MODEL WHICH BEST MATCH RECORDED WITH SIMULATED STREAMFLOWS. PHYSICAL CHARACTERISTICS WERE MEASURED FOR 17 RURAL WATERSHEDS. CORRELATIONS BETWEEN THE CHARACTERISTICS AND THE PARAMETERS WERE EXAMINED. CHANGES IN PARAMETER VALUES WITH URBANIZATION WERE ALSO EXAMINED. THE RESULTS WERE USED TO STUDY VARIATIONS IN DOWNSTREAM FLOOD PEAKS AND IN AVERAGE ANNUAL FLOOD DAMAGES ASSOCIATED WITH VARIOUS TRIBUTARY WATERSHED CHARACTERISTICS.

STREAM FLOW# WATERSHEDS# HYDROLOGY

73W-00-5604

73W 05604. NUMERICAL SIMULATION OF WATERSHED HYDROLOGY.
AUGUST 1970.
TEXAS UNIV., AUSTIN

124P. THE LACK OF CONTROLLED EXPERIMENTS IS ONE OF THE MAJOR OBSTACLES TO HYDROLOGIC RESEARCH. THE RESULT HAS BEEN THE HIGH SPEED DIGITAL COMPUTER, IT HAS BECOME FEASIBLE TO CONSTRUCT A MATHEMATICAL MODEL OF THE ENTIRE RUNOFF PROCESS.

DIGITAL SIMULATION# WATERSHEDS# HYDROLOGY

73W-00-5605

73W 05605. EARTH RESOURCES EVALUATION STUDY (SERIES H-1). PROGRESS REPORT JULY 14 - SEPTEMBER 15, 1971.
SEPTEMBER 1971.
IBM HUNTSVILLE, FSD
NAS8-14000/SA-1883

94P. CONTENTS: TECHNICAL; NEAR TERM ACTIVITIES; RIVER FORECASTING - TECHNICAL APPROACH; AND DATA OBTAINED FOR SELECTED WATERSHED.

HYDROGRAPHY# WATERSHEDS# FLOOD FORECASTING

73W-00-5606

73W 05606. EARTH RESOURCES EVALUATION STUDY (SERIES H-1). WATER FLOW CHARACTERISTIC MODELING STUDY FOR SELECTED WATERSHEDS BY USING AERIAL AND GROUND SENSED DATA.
IBM HUNTSVILLE, FSD

30P. OBJECTIVE: INVESTIGATE THE FEASIBILITY OF APPLYING REMOTE SENSING TO MEASUREMENT, CORRELATION AND PREDICTION OF THE WATER FLOW CHARACTERISTICS OF SELECTED HYDROGRAPHIC CATCHMENTS.

REMOTE SENSING# WATERSHEDS# HYDROGRAPHY

73W-00-5607

73W 05607. APPLICATION OF THE STANFORD WATERSHED MODEL TO A SMALL NEW ENGLAND WATERSHED. AUGUST 1968.
DRUCKER, PB
NEW HAMPSHIRE UNIV., DURHAM

225P. THE STANFORD WATERSHED MODEL IS A COMPUTER PROGRAM WHICH MATHEMATICALLY REPRESENTS THE PORTIONS OF THE HYDROLOGIC CYCLE WHICH ULTIMATELY PRODUCE STREAMFLOW. IT IS UTILIZED TO SYNTHESIZE THE DISCHARGE OF A SMALL NEW ENGLAND WATERSHED. DESCRIPTIONS ARE GIVEN OF PROBLEMS ENCOUNTERED IN ADAPTING THE PROGRAM TO THE UNIVERSITY OF NEW HAMPSHIRE COMPUTER AND IN ADJUSTING THE PROGRAM TO ACCEPT DATA FROM A WATERSHED DIFFERING IN MANY RESPECTS FROM THE WATERSHEDS USED TO DEVELOP THE MODEL. FAIR CORRELATION BETWEEN ACTUAL AND SYNTHETIC DISCHARGE IS ACHIEVED, AND THE USEFULNESS OF THE MODEL WITH REGARD TO VERY SMALL STREAM BASINS IS SHOWN.

WATERSHEDS# MATHEMATICAL MODELS# COMPUTER PROGRAMS

73W-00-5608

TR-12. THE SYNTHESIS OF CONTINUOUS STREAM FLOW HYDROGRAPHS ON A DIGITAL COMPUTER. JULY 1962.
CRAWFORD, NH# LINSLEY, RK
STANFORD UNIV., CALIF.
TR-12

121P. THIS STUDY INVESTIGATED THE FEASIBILITY OF REPRESENTING THE HYDROLOGIC CYCLE IN A WATERSHED BY A DIGITAL COMPUTER MODEL. THE MODEL WAS BASED AS CLOSELY AS POSSIBLE ON THE PHYSICAL PROCESSES PRESENT IN A WATERSHED, AND PRODUCED HOURLY STREAMFLOW HYDROGRAPHS USING DAILY EVAPOTRANSPIRATION AND HOURLY PRECIPITATION DATA. THE BURROUGHS 220 DIGITAL COMPUTER WAS USED FOR CALCULATIONS. THREE CALIFORNIA WATERSHEDS WITH DIVERSE HYDROLOGIC CHARACTERISTICS WERE USED TO TEST THE MODEL AND ILLUSTRATE THE RESULTS OBTAINABLE. SYNTHETIC STREAMFLOW FROM THE MODEL AND OBSERVED STREAMFLOW ARE GENERALLY IN GOOD AGREEMENT, AND IT WAS CONCLUDED THAT THE USE OF THE MODEL IS FEASIBLE. POSSIBILITIES FOR FURTHER DEVELOPMENT ARE SUGGESTED.

WATERSHEDS# MATHEMATICAL MODELS# DIGITAL COMPUTERS

73W-00-5609

RR-40. MEASURING THE INTANGIBLE VALUES OF NATURAL STREAMS, PART 1. APPLICATION OF THE UNIQUENESS CONCEPT. JUNE 1971.
DEARINGER, JA# WOOLWINE, GM
KENTUCKY UNIV., LEXINGTON
RR-40

85P. THE PURPOSE OF THIS STUDY WAS TO APPLY THE UNIQUENESS CONCEPT TO THE QUANTIFICATION OF THE INTANGIBLE VALUES OF NATURAL STREAMS. IT INVOLVES THE EVALUATION OF A SET OF CHARACTERISTICS OR FACTORS FOR SELECTED STREAM SITES. EACH FACTOR IS RATED FOR EACH SITE ON A NUMERICAL SCALE INDICATIVE OF THE RANGE OF POSSIBLE VALUES FOR THAT FACTOR. AN UNIQUENESS RATIO (THE RECIPROCAL OF THE NUMBER OF STREAM SITES SHARING A GIVEN CATEGORY RATING) IS THEN COMPUTED FOR EACH STREAM FOR EACH FACTOR IN THE SET. THE PRESENT STUDY UTILIZED AN INVENTORY OF FIFTY-FOUR FACTORS WHICH WERE EVALUATED FOR EACH STUDY STREAM. THE INVENTORY WAS DIVIDED INTO FIVE FACTOR GROUPS: PHYSICAL MEASURES, LAND USE MEASURES, WATER QUALITY MEASURES, DISVALUES AND ESTHETIC IMPRESSION MEASURES.

STREAMS# LAND USE# WATER QUALITY

73W-00-5610

73W 05610. EARTH RESOURCES EVALUATION STUDY (SERIES H-1). PROGRESS REPORT SEPTEMBER 16 - NOVEMBER 12, 1971. DECEMBER 1971.
IBM HUNTSVILLE, FSD
NAS8-14000/SA-1883

145P. CONTENTS: TECHNICAL PROGRESS: NEAR TERM ACTIVITIES; GENERAL DESCRIPTION AND SAMPLE DATA WHITE HOLLOW WATERSHED; PHOTOGRAPH INTERPRETATION RESULTS; AND SELECTED PROGRAMMING TOPICS.

WATERSHEDS# HYDROGRAPHY# PHOTOINTERPRETATION

73W-00-5612

73W 05612. HYDROLOGIC DIGITAL MODEL OF WILLIAMETTE BASIN TRIBUTARIES FOR OPERATIONAL RIVER FORECASTING. OCTOBER 1967.
KUEHL, DW# SCHERMERHORN, VP
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

38P. THE DIGITAL COMPUTER PROGRAM DEVELOPED TO SYNTHESIZE THE RESPONSE OF A COMPLEX RIVER BASIN TO THE INPUT OF RAINFALL AND SNOWMELT IS DESCRIBED WITH EMPHASIS ON ITS USE IN RIVER FORECASTING OPERATION. APPLICATION OF THE MODEL TO A SAMPLE BASIN IN THE WILLAMETTE DRAINAGE IS SHOWN AND THE MODEL COEFFICIENTS FOR THE ENTIRE NATURAL WILLAMETTE BASIN ARE PRESENTED.

DIGITAL SIMULATION# RIVERS# FORECASTING
HYDROLOGY# COMPUTER PROGRAMS